THREE-BOOK SERIES

STRAYER-UPTON ARITHMETICS

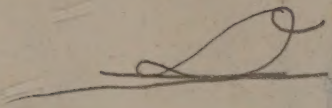
MIDDLE GRADES

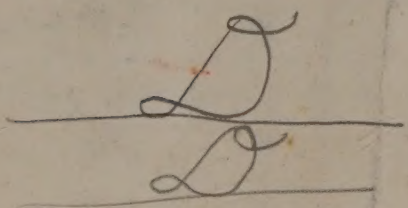
B 2
20

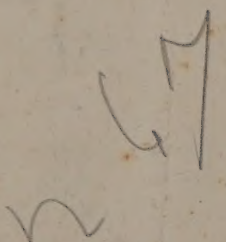
Emma Ada Lucille Harris

September 4, 1934

70 cents







THREE-BOOK SERIES

STRAYER-UPTON ARITHMETICS

MIDDLE GRADES

BY

GEORGE DRAYTON STRAYER, PH.D.
Professor of Education, Teachers College
Columbia University

AND

CLIFFORD BREWSTER UPTON, A.M.
Professor of Mathematics, Teachers College
Columbia University

AMERICAN BOOK COMPANY
NEW YORK CINCINNATI CHICAGO
BOSTON ATLANTA

COPYRIGHT, 1928, BY
AMERICAN BOOK COMPANY
All rights reserved

STRAYER-UPTON ARITHMETICS, MIDDLE GRADES

W. P 37

MADE IN U.S.A.

PREFACE

THIS series of books aims to give children the ability to compute easily and accurately, and to enable them to interpret and solve the quantitative situations which they will meet in life. In the achievement of this aim, these books incorporate the most valuable findings of modern experimentation in the teaching of arithmetic, including the results of important researches conducted by the authors. These books conform to the best modern courses of study and present only those methods and materials which have been thoroughly tested in the classroom by many experienced teachers. In no place do they introduce untried theories.

In this book, which covers the work of the **Middle Grades,** the following features are also noteworthy:

1. The problems have been selected with special care and relate to things that are real and interesting to children. They are expressed in language with which children of the middle grades are familiar.

2. New points are introduced gradually and are explained as simply as possible. In the presentation of the fundamental operations with fractions and decimals, and also in the treatment of percentage, the work has been very carefully graded, so that the pupil is never confronted with more than one new step at a time. Sufficient exercises are provided on each step to give the pupil complete mastery of that step before he proceeds to the next one. Thus his successful progress is assured.

3. Checking is taught early in the presentation of each new operation and is emphasized throughout the book.

4. Since large fractions are rarely used in modern business, the work in common fractions is restricted mainly to fractions with small denominators. This makes it possible to reduce the amount of time formerly devoted to fractions and to give an introductory treatment of decimals in the last half of the fifth grade. After the fundamental operations with fractions have been completed, the subject is reviewed in the subsequent work in denominate numbers, areas, and volumes by the frequent introduction of problems involving fractions.

5. Since the decimal is rapidly gaining in importance in everyday life, often replacing the common fraction, the prominent modern uses of decimals have been included in the problem material of this book.

6. The individual differences of pupils have been amply provided for. The abstract exercises in whole numbers, fractions, decimals, and percentage are so carefully graded and so abundant as to afford even the less able pupil sufficient drill on any types of work that prove difficult for him.

7. In order to furnish an efficient means of developing each pupil's skill in the fundamental operations, a series of Improvement Tests is included, embracing 81 individual tests in whole numbers, fractions, decimals, and percentage. These tests are described on pages 10 to 14.

Chapters I and II of this book cover the work usually given in the fifth grade, and Chapters III and IV cover the work of the sixth grade.

George Drayton Strayer
Clifford Brewster Upton

CONTENTS

CHAPTER I

	PAGE
Addition and Subtraction	1
Improvement Tests	10
Multiplication and Division	15
Problems	33
Reading and Writing Numbers	36
Fractions	38
Adding and Subtracting Fractions	45
Tests of Divisibility	77
Cancellation	79
Multiplying Fractions	82
Review	105

CHAPTER II

Dividing Fractions	109
Comparing Numbers	121
Measures	130
Areas	142
Scale Drawing	146
Volumes	148
Reading and Writing Decimals	152
Adding and Subtracting Decimals	156
Multiplying and Dividing Decimals	163
Review	178

CHAPTER III

PAGE

Improvement Tests 183
Review of Whole Numbers 186
Problem Solving 191
Fractions 198
Adding and Subtracting Fractions 201
Multiplying and Dividing Fractions 207
Reading Decimals 214
Adding and Subtracting Decimals 221
Multiplying Decimals 228
Dividing Decimals 235
Review 257

CHAPTER IV

Bills and Receipts 263
Checks 267
Parcel Post 270
Percentage 272
Commission 293
Profit and Loss 295
Discount 298
Interest 302
Measures 309
Review 336

Tables for Reference 341
Index 343

MIDDLE GRADES

CHAPTER I

OUR NATURE STUDY CLUB

1. Our Nature Study Club has 35 members who pay weekly dues of \$.05 each. How much does Ted, the treasurer, collect in dues in 1 week? in 4 weeks?

2. During the first four weeks Ted pays out the following amounts. How much does he pay in all?

(*a*) \$1.15 for glass and cement to make an aquarium.

(*b*) \$1.50 for bird records for the phonograph.

(*c*) \$.75 for a blue print outfit.

(*d*) \$.49 for a box of blue print paper.

(*e*) \$2.75 to rent a motion picture film of wild animals.

3. If the total amount Ted receives during the four weeks is \$7.00, how much has he left after paying out the amounts mentioned in ex. 2?

The next page shows how Ted keeps his accounts.

TED'S ACCOUNT BOOK

As treasurer of the Nature Study Club, Ted keeps this account of all the money he receives and spends.

Received					Paid Out				
Sept.	12	Dues	1	75	Sept.	15	Glass and cement	1	15
"	19	Dues	1	75	"	20	Phonograph records	1	50
"	26	Dues	1	75	"	28	Blue print outfit		75
Oct.	3	Dues	1	75	Oct.	2	Blue print paper		49
					"	6	Film rent	2	75
						6	Cash on hand		36
			7	00				7	00
Oct	6	Cash on hand		36					

How much in all does Ted receive during the four weeks? How much in all does he spend?

Ted subtracts the $6.64 he spends from the $7.00 he receives, which gives $.36 as the amount of cash he *should have* on hand. This is his **balance.** He counts his cash and finds that he really has $.36 left. Then he writes " Cash on hand, $.36 " on the right side of his book, as shown above, and adds that side. The sum is $7.00 and his book *balances* because the left side also totals $7.00. He draws double lines under $7.00 on both sides to show that the account above these lines is correct.

He now starts a new section of his account by writing " Cash on hand, $.36 " on the left side under $7.00.

In balancing his book, if Ted finds that he has not $.36 left, he tries to discover his mistake. If he has *less* than $.36, he may have forgotten to record some amount that he has spent; if he has *more* than $.36, he may have failed to record some amount that he has received.

TED CHECKS HIS ADDITION

Ted finds that the best way to add is to begin at the bottom of each column and add up. After obtaining the sum, he checks the work by beginning at the top of each column and adding down. If he gets the same sum each time, he considers that his work is correct.

Exercises

1. Here is the next section of Ted's account. Copy it, balance the account, and check the addition.

Received					Paid Out				
Oct.	6	Cash on hand		36	Oct.	14	Book of Birds	1	45
"	10	Dues	1	75	"	18	Rock specimens	2	40
"	17	Dues	1	75	"	25	Postage		12
"	24	Dues	1	75	"	31	Trip to park	2	50
"	31	Dues	1	75	Nov.	1	Cash on hand		

2. For the next four weeks Ted starts with a balance of \$.89 and receives \$1.75 in dues each week. He pays \$.65 for express on lantern slides, \$.95 for a class excursion, \$1.35 for "Book of Trees," \$.85 for lumber for bird houses, \$.75 for fish for the aquarium. Insert dates and make out and balance Ted's account. Check the work.

3. On Dec. 1 Ted has a balance of \$3.34. On Dec. 5 he collects dues of \$1.75 and each of the next two weeks he collects the same amount. He spends \$.75 for food for squirrels, \$1.65 for paper for costumes for a bird play, \$.95 for pictures of trees, \$.65 for express, \$1.00 for a prize for the best photograph of animals. Balance the account to find the amount he should have left. Check the work.

ANNA'S CASH BOOK

1. Here are two pages from Anna's cash book. On the left-hand page she writes the amounts she receives. On the right-hand page she writes what she spends.

Received					Paid Out				
Sept.	1	Cash on hand	2	06	Sept.	7	Story book	1	07
"	5	Allowance	1	00	"	12	Ice cream		10
"	9	For old reader		35	"	18	Picnic		35
"	11	Errands		30	"	23	Red Cross Fund		40
"	19	Allowance	1	00	"	24	Set of paints	1	04
"	26	From Aunt Jess		50	"	30	Cash on hand		

Balance Anna's account to show that she should have $2.25 on hand on Sept. 30.

2. On Sept. 30 Anna counts her money and finds that she has only $2.15 (see ex. 1). Grace says that this might mean that she lost $.10. Is Grace right?

3. Anna is sure that she did not lose any money. Then she remembers that she spent $.10 for candy on Sept. 29. How does this change her account?

4. Show how Anna should keep her cash account for January. She has $1.19 on hand on Jan. 1. She receives $5.00 as a New Year's present, $1.75 on Jan. 7 for running errands, and $1.91 on Jan. 16 for helping her aunt. She spends $2.25 on Jan. 5 for a pair of skates, $.75 on Jan. 16 for a present for her sister, $.84 on Jan. 19 for a game, and $.65 on Jan. 24 for ribbon. How much cash should she have on hand on Jan. 31?

5. Keep a cash account as Anna did. As soon as you receive or spend any money, make a record of it.

DRILL IN ADDITION

Add orally, starting at the bottom. Check by adding down:

1.	2.	3.	4.	5.	6.	7.	8.
8	7	9	3	4	3	8	8
4	5	6	4	6	8	2	0
2	0	6	5	5	4	4	4
5	9	8	8	0	6	9	8
0	6	2	6	9	7	8	6
9	7	7	2	7	9	4	5
5	3	8	5	2	0	4	7

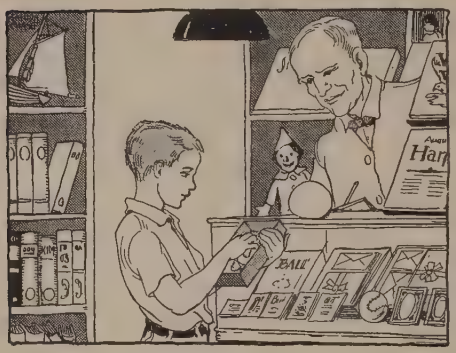
Copy and add, starting at the bottom. Check the work:

9.	10.	11.	12.	13.	14.
89	19	83	31	70	66
43	93	29	16	33	72
20	77	28	55	62	81
69	45	32	28	84	46
98	78	64	57	11	42
53	32	68	34	19	57

15.	16.	17.	18.	19.	20.
99	97	27	92	24	43
70	41	96	59	61	17
75	47	61	94	36	88
31	98	42	25	80	50
60	60	80	75	58	78
47	21	92	10	59	98

21.	22.	23.	24.	25.	26.
388	680	369	569	390	968
330	575	457	792	915	287
661	394	778	725	645	626
125	203	303	502	473	250
674	882	544	396	779	183

THE EXPENSES OF A TOY STORE



1. Mr. Grant runs a small toy and stationery store in Johnstown. During August he spends \$276.20 for supplies, \$10.14 for lighting, \$60.00 for rent, \$9.00 for advertising, and \$37.60 for help. How much are the expenses of his store during August?

Here are the August expenses of some other small stores. Copy them and find the total expenses of each store. Check the answers:

2.	\$167.05	**3.**	\$178.37	**4.**	\$146.26	**5.**	\$221.93
	39.54		13.03		20.59		77.80
	16.82		75.69		86.69		54.79
	85.78		68.47		51.90		65.58
6.	\$189.49	**7.**	\$101.95	**8.**	\$200.94	**9.**	\$330.40
	33.23		24.30		69.23		26.96
	20.41		51.74		53.80		42.57
	14.68		68.92		12.77		99.08
	47.89		42.39		30.95		74.80
10.	\$330.77	**11.**	\$162.51	**12.**	\$257.80	**13.**	\$ 79.67
	158.83		350.09		43.52		110.67
	80.40		46.39		40.44		188.06
	64.18		71.53		18.07		45.23
	25.68		26.00		189.16		89.59

ANSWERING QUESTIONS BY SUBTRACTING

1. Emma had \$3. She gave \$.14 to her little brother. How much had Emma left?

First write \$3 as \$3.00. Then subtract \$.14 from \$3.00, making sure that the decimal points are under each other.

\$3.00	**Minuend**
.14	**Subtrahend**
\$2.86	**Remainder**

You find that Emma had \$2.86 left.

To *check* the answer, add \$2.86 and \$.14, beginning at the bottom and adding up, thus: $6 + 4 = 10$; 1 (carried) $+ 8 + 1 = 10$; 1 (carried) $+ 2 = 3$. The sum is \$3.00, which is the same as the minuend; hence the work is right.

In the above problem, \$2.86 is called the **remainder.**

2. Tony has saved \$4.20. Jim has saved \$2.57. How much less has Jim saved than Tony?

Here you subtract to find the *difference* between Tony's and Jim's savings.

\$4.20	
2.57	
\$1.63	**Difference**

3. Alfred has \$6.42. He needs \$8.50 to buy a coaster. How much more does he need?

4. Mollie has \$7.45. She spends \$2 and puts the rest in a savings bank. How much does she put in the bank?

5. Abraham Lincoln was born in 1809. He was killed in 1865. How old was he at the time of his death?

6. In 1927 Lindbergh flew about 3647 mi., without stopping, in going from New York to Paris. A few weeks later Chamberlin flew about 4400 mi. from New York to Germany. How much longer was Chamberlin's trip than Lindbergh's?

7. Subtraction answers several kinds of questions, like "How much is left?" "How much farther?" and "What is the difference?" Make up six subtraction problems, each having a different kind of question.

A SUBTRACTION RACE

Do not copy these problems. Place the edge of your paper under the top row of problems. Write the answers along that edge of the paper, checking your work as you do it. Then fold the answers under and write the next row of answers along the folded edge.

As soon as one pupil finishes, the entire class stops. The one who then has the most problems correct wins.

Subtract, and check the work:

1.	2967 585	**8.**	6384 747	**15.**	7475 3994	**22.**	6354 5549
2.	7253 324	**9.**	8252 482	**16.**	9629 7656	**23.**	9215 2631
3.	4850 170	**10.**	4126 881	**17.**	5001 3331	**24.**	7009 5247
4.	5647 388	**11.**	8446 3666	**18.**	7275 2299	**25.**	8910 1429
5.	8913 972	**12.**	3263 1871	**19.**	8526 7894	**26.**	5419 2888
6.	4301 750	**13.**	5800 2611	**20.**	8000 2546	**27.**	7912 4886
7.	9094 765	**14.**	9319 3650	**21.**	4314 3491	**28.**	3209 1669

HOW WE MAKE CHANGE

Fred is a clerk in a grocery store. Anna buys a dozen eggs for 38¢ and gives him a 1-dollar bill.

To make change for Anna, Fred first thinks 38¢; then he takes 2 cents and thinks 40¢; then he takes a dime and thinks 50¢; then he takes a half dollar and thinks $1. As he gives Anna the coins, he counts them again, saying, "38, 40, 50, $1." Anna counts with him to make sure that the change is right.

To check your change, start with the cost of your purchase and add to it the coins that the clerk gives you. The sum should equal the amount that you gave the clerk.

Making Change

1. Tess buys a basket of apples for 69¢. She gives the clerk $1. He gives her a cent, a nickel, and a quarter. Count the change as the clerk did. Is it right?

2. Martha buys a 7-cent notebook and gives the clerk a quarter. The clerk gives her 3 cents, a nickel, and a dime. Count out the change with the clerk.

3. Edward buys 15¢ worth of rolls and hands the clerk $1. The clerk gives him 2 nickels, 2 dimes, and a half dollar as change. Count the change. Is it right? What change should the clerk give Edward?

Tell what coins you would give as change for $1 *on each of these purchases:*

4. 83¢ **6.** 59¢ **8.** 91¢ **10.** 72¢ **12.** 68¢ **14.** 60¢

5. 22¢ **7.** 41¢ **9.** 29¢ **11.** 33¢ **13.** 9¢ **15.** 16¢

Make change from $5 *for these purchases:*

16. $1.23 **17.** $2.07 **18.** $3.12 **19.** $2.28 **20.** $3.64

HOW TO IMPROVE YOUR SKILL IN COMPUTING

You are all anxious to improve your skill in computing. You can do this if you practice faithfully; but you may find that you do not improve very much *unless you practice in the right way.* Suppose that you wish to improve your ability in the standing broad jump. You will improve somewhat if you practice jumping each day; but you will make the fastest progress if you *carefully measure* the longest distance you jump to-day, and write it down, and *then try hard to jump a little farther to-morrow.* Every athlete watches his record carefully in this way and *always tries to improve it.*

If you wish to add as well as or better than any other pupil in your class, you must watch your record and *always try to improve it.*

A good way to do this is by means of Improvement Tests, such as Test 1 A in Addition given on page 11. When you try this test, the teacher will time you, telling you when to start and when to stop. At the end of the 4 minutes allowed for the test, the teacher will read the correct answers and you should see how many examples you have right. Then find your score on the test.

Try the same test again *the next day, doing your best to improve your score.* Repeat the test as often as the teacher directs, trying to get all the problems right, if possible, in 4 minutes.

The teacher will tell you when to try Test 1B. Write down your score each time that you take a test, keeping your record as shown on page 14. See pages 12 and 13 for other directions.

Always try to improve upon your best previous record.

IMPROVEMENT TEST No. 1

Test 1 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.
287	791	578	148	284
395	706	845	263	495
906	268	659	587	509
331	519	763	264	787
6.	**7.**	**8.**	**9.**	**10.**
217	267	149	666	838
143	654	804	397	343
294	495	755	360	529
949	801	803	373	418

Test 1 B — Subtraction (Time 4 min.)

1.	2.	3.	4.	5.
1141	4065	8223	9169	6824
372	530	3284	974	885
6.	**7.**	**8.**	**9.**	**10.**
1342	2000	7011	9817	3570
786	1262	1043	5919	2856
11.	**12.**	**13.**	**14.**	**15.**
1688	7863	2009	8493	5492
391	355	460	2909	662

Test 1 C — Addition (Time 4 min.)

1.	2.	3.	4.	5.
128	959	897	698	169
407	257	332	725	370
826	349	806	590	138
532	160	758	844	901
790	741	391	104	749
336	254	217	476	776
901	162	743	835	819
290	908	489	948	346

HOW TO TAKE AN IMPROVEMENT TEST

When you are taking an Improvement Test in addition, subtraction, or short division, like Test 1 A, 1 B, or 3 A, do not copy the examples. Instead, place the edge of a sheet of paper directly under the first row of examples in the test, and write only the answers along that edge of the paper. Then fold these answers under and write the next row of answers along the folded edge.

For an Improvement Test in multiplication or long division, like Test 2 C or 3 C, the examples should be copied on paper before the test begins. In copying, spread the examples out so as to give sufficient space for working them. The time allowed for the tests in multiplication and long division does not include the time required for copying.

Work on each test only the number of minutes permitted for that test, and stop work *immediately at the end of that time*, even if you are just finishing an example. Otherwise it will not be possible to compare your scores from day to day on the same test.

If you finish a test before the signal to stop, check as many of the examples as you can in the remaining time. Occasionally the teacher will have you check the entire test, allowing you twice as long for doing and checking all the examples as for only doing them once.

FINDING YOUR SCORE IN AN IMPROVEMENT TEST

This table shows how to find your score on a test.

NUMBER OF EXAMPLES IN TEST	NUMBER OF EXAMPLES RIGHT																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
3	0	3	7	10													
4	0	3	5	8	10												
5	0	2	4	6	8	10											
6	0	2	3	5	7	8	10										
8	0	1	3	4	5	6	8	9	10								
9	0	1	2	3	4	6	7	8	9	10							
10	0	1	2	3	4	5	6	7	8	9	10						
12	0	1	2	3	3	4	5	6	7	8	8	9	10				
A → 15	0	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	
16	0	1	1	2	3	3	4	4	5	6	6	7	8	8	9	9	10

B

C

1. Suppose that you take Test 1 B, which contains 15 examples, and get 12 examples right. Look down the first column to the *row* beginning with 15 (shown by Arrow A). Look *along that row* until you reach the *column* with 12 at the top (shown by Arrow B), and you will find the number 8 (shown by Arrow C). This means that your score is 8 on that test.

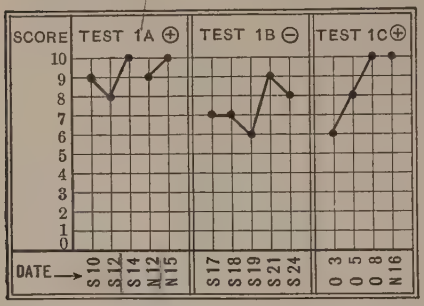
2. In Test 1 A (containing 10 examples), if you get 8 examples right, your score is 8; if you get 10 examples right, your score is 10, or perfect.

3. In finding your score, count only the examples that are entirely right. A partly finished example does not count.

Use the above table to find Frank's scores in these tests:

Number in test	5	8	8	9	10	10	12	12	12	15
Number right	4	5	7	5	7	9	8	10	12	14

GRAPHS OF RECORDS IN IMPROVEMENT TESTS



Here is a picture, or **graph,** of Carl's daily scores. Such a picture is the best way to keep your record.

The dates on which Carl tried each test are given below the bottom line of the graph. S 10 means Sept. 10, which is the first day on which Carl tried Test 1 A. The heavy black dot above S 10, on the horizontal line marked 9, shows that Carl got a score of 9 on Sept. 10. The months are abbreviated as shown at the right.

S = Sept.	F = Feb.
O = Oct.	M = Mar.
N = Nov.	A = Apr.
D = Dec.	My = May
J = Jan.	Ju = June

Reading the Graph of Carl's Record

1. What was Carl's score on Sept. 12? Did he do as well then as on Sept. 10? Did he improve on Sept. 14?

2. How many times did he try Test 1 A before he got a score of 10, or a perfect score?

3. How long after he first got a score of 10 did he try Test 1 A again? What was his score on Nov. 12?

4. Did Carl do as well on Test 1 B as on 1 A? What was his first score on Test 1 B? his lowest score? his last score? Does he need more practice on Test 1 B?

5. Tell his lowest and his highest score on Test 1 C.

6. On which test did Carl improve the most rapidly?

BUYING SUPPLIES FOR THE SCHOOL STORE

At the beginning of the school year, our school store buys 25 fountain pens at $1.46 each. How much do the pens cost in all?

Multiplying $1.46 by 25, you find that the pens cost $36.50 in all.

Remember to write the sign $ before the product and to separate the dollars and cents by a decimal point.

Check the problem by doing it again or by going very carefully over all the work you have done.

$1.46	**Multiplicand**
25	**Multiplier**
7 30	
29 2	
$36.50	**Product**

In the above example, $1.46 and 25 are called the **factors** and the answer is the **product.**

Exercises

Find the cost of these supplies for the school store:

1. 78 school pins at $.77 each.
2. 35 scout watches at $1.32 each.
3. 35 geographies at $1.27 each.
4. 78 arithmetics at $.72 each.
5. 95 readers at $.84 each.
6. 62 spelling books at $.43 each.
7. 50 writing pads at $.18 each.
8. 48 histories at $.94 each.
9. 36 canvas school bags at $1.28 each.
10. 64 loose-leaf binders at $.29 each.
11. 18 water-color paint sets at $.45 each.
12. 24 dozen notebooks at $1.08 a dozen.
13. 20 boxes of lead pencils at $3.27 a box.

PRACTICE IN MULTIPLICATION

Copy these examples. Then multiply as rapidly as you can. Check each example by going over your work carefully:

1.	576 43	**6.**	725 29	**11.**	918 82	**16.**	862 75	**21.**	829 45
2.	275 86	**7.**	517 57	**12.**	942 63	**17.**	316 59	**22.**	609 38
3.	346 27	**8.**	316 38	**13.**	603 76	**18.**	248 83	**23.**	347 56
4.	436 59	**9.**	809 65	**14.**	754 28	**19.**	509 69	**24.**	945 17
5.	489 91	**10.**	829 47	**15.**	134 94	**20.**	476 34	**25.**	827 29

Multiply and check. Be sure to put the decimal point and the dollar sign where they belong in the product:

26.	\$62.51 39	**30.**	\$16.87 96	**34.**	\$12.68 36	**38.**	\$38.53 73
27.	\$46.93 82	**31.**	\$49.05 65	**35.**	\$92.05 19	**39.**	\$57.12 67
28.	\$49.17 37	**32.**	\$35.28 48	**36.**	\$26.70 48	**40.**	\$30.26 47
29.	\$59.24 69	**33.**	\$68.05 47	**37.**	\$70.52 83	**41.**	\$81.07 76

ANOTHER WAY TO CHECK MULTIPLICATION

Multiplication can always be checked by going over the work again. Another way to check multiplication is to change the position of the factors and multiply again. This is called *reversing the factors.* If you have found 75×83, you can check the result by finding 83×75. The product will be the same both ways if the work is correct.

Example	*Check*
83	75
75	83
415	225
581	600
6225	6225

Use the method of checking explained above when both factors have the same number of figures. Otherwise check by going over the work again.

Exercises

Multiply. Check the work by reversing the factors:

1.	2.	3.	4.	5.	6.
54	76	48	52	87	85
98	43	52	26	19	37

Multiply. Check by going over the work again:

7.	8.	9.	10.	11.
9421	2843	3176	3756	6382
65	74	92	15	68

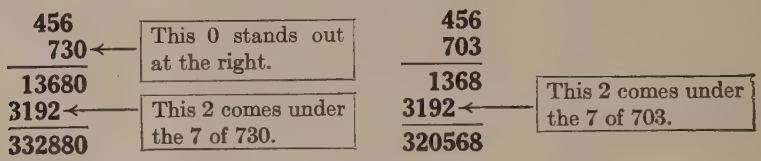
Multiply the following. Tell which check you will use for each problem, and then check it:

12.	13.	14.	15.	16.
197	496	209	623	5926
86	7	89	83	9

17.	18.	19.	20.	21.
731	459	492	376	806
217	342	571	356	684

TAKING CARE OF 0's IN MULTIPLICATION

Unless you watch the 0's in a multiplication example they may cause you trouble. Study these examples carefully so that you will know what to do with the 0's.



Exercises

Check these problems the new way shown on page 17.

1. Herman has a news stand at Red Oaks Station. He sells, on an average, 126 papers a day. If he works 350 days in a year, how many papers does he sell in a year?

2. The Westfield School has 409 pupils. The cost of the school is estimated at $105 a year for each pupil. How much does the school cost in a year?

3. May Jones makes about 108 paper flowers a day. When she works 230 days in a year, how many flowers does she make in a year?

Multiply. Check by reversing the factors:

4.	683 740	**7.**	649 690	**10.**	803 609	**13.**	579 408	**16.**	357 407
5.	459 380	**8.**	503 260	**11.**	298 203	**14.**	207 702	**17.**	245 208
6.	409 570	**9.**	836 850	**12.**	457 503	**15.**	506 708	**18.**	653 309

SAVING TIME IN MULTIPLICATION

The owner of a radio shop is finding how much 132 storage batteries will cost him at \$9 each.

He must multiply \$9 by 132. This could be done as shown in *A*, but it is much easier to multiply as shown in *B*. Notice that 9×132 gives the same product as 132×9, just as 5×7 equals 7×5.

When you do the work as shown in *B*, remember that the result, 1188, stands for *dollars* because you are finding the cost.

A	*B*
9	132
132	9
18	1188
27	
9	
1188	

If one factor has fewer figures than the other, it is always quicker to multiply by the factor with the fewer figures.

Exercises

Multiply the quicker way. Then decide if the answer stands for dollars, yards, or some other unit.

1. Find the cost of 48 hats at \$5 each.

2. There are 304 girls in the Fitch School. Each girl needs 2 yd. of blue crêpe paper for a parade costume. How many yards of blue crêpe paper are needed?

3. Richard sells magazines at 15¢ each. How much will he collect for 185 magazines?

4. David has 14 chickens. A poultry farm has 258 times as many. How many chickens has the poultry farm?

Have a race with a boy or a girl in your class to see who can do these examples most quickly:

5. 186×4 hr.	**8.** $182 \times \$2$	**11.** $432 \times 3¢$
6. 165×9 yd.	**9.** $156 \times \$5$	**12.** $287 \times 4¢$
7. 901×7 ft.	**10.** $307 \times \$8$	**13.** $129 \times 11¢$

MRS. FISKE'S CANDY SHOP

1. Mrs. Fiske has a candy store near our school. She makes 48 boxes of nut fudge, which she sells at 19¢ a box. How much does she get for the fudge?

2. She also makes 104 bars of molasses taffy for which she charges 5¢ a bar. If she sells all the taffy, how much does she receive for it?

3. Mrs. Fiske fills glass jars with hard candies. If she puts 50 candies in a jar, how many candies will she need in order to fill 84 jars?

4. Last week Mrs. Fiske sold 327 plates of ice cream at 15¢ each. How much did she get in all for it?

5. At Easter she bought from a candy factory 36 pound boxes of chocolates at $.78 a box and 27 two-pound boxes at $1.39 a box. How much was her total bill?

6. Bert bought a box of small mints from Mrs. Fiske. He counted 210 mints in the box. How many mints would there be in 35 such boxes? in 50 boxes? in 125 boxes?

7. In one day Mrs. Fiske sold to school children 97 pieces of candy at 1¢ each. How much in all did she receive for them? If she sold the same amount each day, how much would she receive in 198 school days?

IMPROVEMENT TEST No. 2

Test 2 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.
5267	3746	1479	1796	6692
2090	9604	5610	7360	8787
4128	5534	3562	3918	9943
6896	8175	8884	9583	5019
7137	4955	4469	5377	2671
8502	2002	7335	2768	5936

Test 2 B — Subtraction (Time 4 min.)

1.	2.	3.	4.	5
4910	9571	7412	6075	6635
1340	5681	2543	4172	4539

6.	7.	8.	9.	10.
6375	9300	8243	5517	9822
1777	4587	4696	2980	6942

11.	12.	13.	14.	15.
7501	4000	8423	3168	9349
6340	1527	3182	2898	3187

Test 2 C — Multiplication (Time 5 min. after copying)

1.	2.	3.	4.
765	915	508	790
35	46	72	83

5	6.	7.	8.
948	826	467	975
65	94	27	49

Test 2 D — Multiplication (Time 4 min. after copying)

1.	2.	3.	4.	5.
975	769	716	543	674
805	314	195	792	806

NOTE. For directions for taking the above tests, see page 12.

BUYING REMNANTS

1. Janet bought a remnant containing 4 yards of crêpe silk for $3.93. How much did she pay per yard?

Divide $3.93 by 4. The answer is $.98, with a remainder of $.01.

Hence Janet paid a little over $.98 a yard.

To check, multiply the quotient, $.98, by the divisor, 4, and add the remainder, $.01. Since the result, $3.93, equals the dividend, the work is right.

			Check
Divisor 4)	$3.93	Dividend	$ .98
	$ .98	Quotient	4
	$ .01	Remainder	$3.92
			.01
			$3.93

To check division, multiply the quotient by the divisor and add the remainder. The result should equal the dividend.

2. Albert buys felt to make school banners. How much does he pay per yard if he gets a 7-yard piece for $18.55? if he gets a 3-yard piece for $7.50?

3. If a 9-yard remnant costs $18.27, what is the cost per yard?

4. If a 3-yard remnant costs $5.70, what is the cost per yard?

Other Problems

1. Six boys bought a football for $2.94. How much did each pay if they shared the expense equally?

2. Rose made a train trip of 290 mi. in 9 hr. The train traveled a little over how many miles an hour?

3. Mrs. Allen's 8 grandchildren are saving money to buy her a rocking chair costing $32.40. How much will each need to save if they divide the cost equally?

4. The 226 girls of the Park School plan to march in rows of 7's in a parade. How many rows will they make? Will any girls be left over?

PRACTICE IN SHORT DIVISION

Practice these problems until you can do them quickly. Check the work by multiplying, as shown on page 22:

1.	2)108	19.	6)854	37.	2)1342	55.	9)9540
2.	4)252	20.	8)316	38.	8)2165	56.	4)1360
3.	3)216	21.	9)367	39.	7)1449	57.	5)1047
4.	8)544	22.	4)239	40.	3)2550	58.	5)2532
5.	5)525	23.	2)578	41.	7)4335	59.	8)2528
6.	6)504	24.	3)494	42.	8)8064	60.	6)6036
7.	9)540	25.	5)348	43.	6)2430	61.	7)3049
8.	7)525	26.	8)438	44.	9)2133	62.	3)1251
9.	4)115	27.	9)981	45.	5)5150	63.	5)4045
10.	2)615	28.	6)461	46.	2)1653	64.	4)1043
11.	7)483	29.	4)435	47.	4)3608	65.	7)1456
12.	3)928	30.	6)235	48.	6)4938	66.	2)1810
13.	4)188	31.	7)1428	49.	8)4343	67.	5)2140
14.	5)140	32.	9)4714	50.	9)1419	68.	9)1845
15.	8)856	33.	6)1245	51.	7)7490	69.	6)6001
16.	7)586	34.	5)2185	52.	3)1874	70.	2)1750
17.	3)257	35.	9)6372	53.	9)3672	71.	5)3745
18.	5)535	36.	4)3043	54.	2)1186	72.	6)3606

LONG DIVISION

Mr. Dane is driving from Savannah to California and back, a total distance of 7939 mi. If he averages 23 mi. an hour, how many hours will he have to drive?

In dividing 7939 by 23, use the following rule:

When a two-figure divisor ends in 1, 2, 3, 4, *or* 5, *divide by the first figure of the divisor to estimate each figure of the quotient.*

1. Since the first figure of 23 is 2, divide by 2 to estimate quotient figures. The first partial dividend is 79. *Dividing* 7 by 2, you get 3 as the first quotient figure. Write 3 over 9 of 79. *Multiply* 23 by 3, which gives 69. *Subtract* 69 from 79, which gives a remainder of 10. *Compare* 10 with the divisor, 23. Since 10 is less than the divisor, this shows that 3 is the right quotient figure.

```
      345          Check
23)7939            345
   69               23
   ---            ----
   103            1035
    92            690
   ---            ----
    119           7935
    115              4
   ---            ----
R    4           7939
```

When you have the right quotient figure, the remainder will always be less than the divisor.

2. *Bring down* 3, which gives 103 as the next partial dividend. Dividing 10 by 2 would give 5 as the second quotient figure. But when you multiply 23 by 5, you get 115, which is too large to be subtracted from 103. Hence try 4. Why is 4 right?

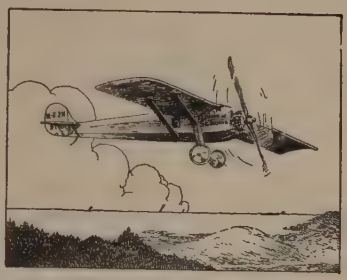
When the rule gives a quotient figure that is too large, try the next smaller figure.

3. *Bring down* 9, which gives 119 as the next partial dividend. Divide 11 by 2, which gives 5 as quotient. Why is 5 right?

The quotient is 345, with a remainder of 4. Hence Mr. Dane will have to drive a little over 345 hr. in all.

Check the work by multiplying 345 by 23 and adding 4.

TRAVELING AT DIFFERENT SPEEDS



1. A United States army monoplane flew from New York to San Diego, traveling 94 mi. an hour. The airline distance between the two cities is about 2538 mi. How many hours did the trip take by airplane?

2. The distance by train from New York to San Diego is 3238 mi. If a train averaged 34 mi. an hour, it would take a little over how many hours to make this trip?

3. If you could walk the 3238 mi. from New York to San Diego at the rate of 22 mi. a day, about how many days of walking would the trip require?

Exercises

Divide and check, using the rule on page 24 *to find the quotient figures. Write R before the remainder, if any:*

1. 5124 ÷ 21	**12.** 1911 ÷ 21	**23.** 18,396 ÷ 42
2. 7136 ÷ 32	**13.** 1935 ÷ 55	**24.** 18,414 ÷ 62
3. 1584 ÷ 22	**14.** 9961 ÷ 43	**25.** 28,861 ÷ 73
4. 2688 ÷ 64	**15.** 3330 ÷ 74	**26.** 15,264 ÷ 53
5. 5775 ÷ 25	**16.** 5719 ÷ 42	**27.** 55,876 ÷ 61
6. 6466 ÷ 53	**17.** 4768 ÷ 91	**28.** 29,736 ÷ 63
7. 7949 ÷ 81	**18.** 9072 ÷ 24	**29.** 18,975 ÷ 75
8. 1798 ÷ 35	**19.** 9980 ÷ 34	**30.** 62,560 ÷ 85
9. 8835 ÷ 95	**20.** 2436 ÷ 42	**31.** 19,932 ÷ 44
10. 5325 ÷ 75	**21.** 1045 ÷ 55	**32.** 26,424 ÷ 72
11. 8879 ÷ 72	**22.** 9021 ÷ 31	**33.** 26,979 ÷ 51

LONG DIVISION

Mrs. Blake is buying a small house costing \$6815. She is paying for the house at the rate of \$29 per month. How many months will it take her to pay for it?

In dividing 6815 by 29, use this rule:

When a two-figure divisor ends in 6, 7, 8, *or* 9, *divide by* 1 *more than the first figure of the divisor to estimate each quotient figure.*

Since the first figure of 29 is 2, use 3 as the trial divisor. You may do this since 29 about equals 30.

1. To find the first quotient figure, think "$6 \div 3 = 2$." Trying 2 as the quotient, you get the remainder 10, which is less than the divisor. Hence 2 is the right quotient.

2. How is 3 obtained as the second quotient figure? Is the remainder less than the divisor?

3. For the third quotient figure, think "$14 \div 3$ gives 4." Trying 4 as quotient, you get a remainder of 29, which *is equal* to the divisor. Hence 4 is too small. Try 5.

It will take Mrs. Blake 235 mo. to pay for the house.

```
 235
29)6815
 58
 101
  87
  145
  145
```

When the remainder is equal to or larger than the divisor, try the next larger figure as quotient.

Exercises

Divide, using the above rule. Check by multiplying:

1. $1669 \div 79$	**6.** $1779 \div 97$	**11.** $16{,}504 \div 38$
2. $1654 \div 37$	**7.** $1320 \div 28$	**12.** $35{,}154 \div 69$
3. $9792 \div 28$	**8.** $2686 \div 79$	**13.** $26{,}136 \div 36$
4. $4632 \div 59$	**9.** $5592 \div 69$	**14.** $18{,}984 \div 28$
5. $4422 \div 56$	**10.** $7310 \div 86$	**15.** $17{,}591 \div 49$

DRILL IN LONG DIVISION

Divide and check. Write R before the remainder:

1. 5145 ÷ 21	**23.** 6094 ÷ 27	**45.** 29,736 ÷ 63
2. 7471 ÷ 31	**24.** 3659 ÷ 57	**46.** 10,028 ÷ 23
3. 2035 ÷ 55	**25.** 3072 ÷ 48	**47.** 24,667 ÷ 43
4. 2052 ÷ 33	**26.** 8035 ÷ 45	**48.** 16,504 ÷ 38
5. 1230 ÷ 39	**27.** 9858 ÷ 53	**49.** 53,756 ÷ 89
6. 2412 ÷ 67	**28.** 6293 ÷ 73	**50.** 28,497 ÷ 69
7. 1751 ÷ 56	**29.** 1897 ÷ 59	**51.** 16,836 ÷ 92
8. 5876 ÷ 52	**30.** 3128 ÷ 46	**52.** 17,990 ÷ 35
9. 7810 ÷ 55	**31.** 9747 ÷ 68	**53.** 12,244 ÷ 44
10. 1216 ÷ 64	**32.** 5960 ÷ 41	**54.** 28,178 ÷ 73
11. 5644 ÷ 83	**33.** 4510 ÷ 92	**55.** 63,427 ÷ 91
12. 2736 ÷ 28	**34.** 5798 ÷ 78	**56.** 44,030 ÷ 85
13. 2795 ÷ 38	**35.** 6263 ÷ 88	**57.** 73,079 ÷ 89
14. 8227 ÷ 46	**36.** 9664 ÷ 64	**58.** 47,817 ÷ 77
15. 2790 ÷ 45	**37.** 8989 ÷ 24	**59.** 48,926 ÷ 77
16. 6408 ÷ 24	**38.** 3029 ÷ 39	**60.** 15,561 ÷ 21
17. 2410 ÷ 52	**39.** 2711 ÷ 37	**61.** 19,723 ÷ 62
18. 3589 ÷ 49	**40.** 4864 ÷ 76	**62.** 14,011 ÷ 19
19. 5592 ÷ 69	**41.** 5273 ÷ 19	**63.** 35,789 ÷ 89
20. 9108 ÷ 99	**42.** 5131 ÷ 74	**64.** 14,048 ÷ 42
21. 1701 ÷ 81	**43.** 5896 ÷ 47	**65.** 10,990 ÷ 52
22. 9834 ÷ 33	**44.** 4256 ÷ 56	**66.** 37,890 ÷ 59

NOTE. For all two-figure divisors above 18, the trial quotient figure, obtained by using the rules near the top of pages 24 and 26, is the correct quotient figure three times out of every four. When the divisor is 14, 15, 16, 17, or 18, the quotient figures must be found by trial, since no rule is satisfactory for these five divisors.

QUOTIENTS THAT CONTAIN ZEROS

1. The children in our class picked 880 daisies. If these were put in 22 bunches, how many daisies did each bunch contain?

The first figure of the quotient is 4. $4 \times 22 = 88$, and $88 - 88$ leaves no remainder.

Bring down the 0 of the dividend. Since $0 \div 22 = 0$, the second quotient figure is 0.

The quotient is 40.

Hence each bunch contained 40 daisies.

$$\begin{array}{r} 40 \\ 22\overline{)880} \\ 88 \\ \hline 0 \\ 0 \\ \hline \end{array}$$

2. In a large school assembly hall there are 25 seats in a row. How many rows do 2728 children fill?

The first quotient figure, 1, leaves a remainder of 2. Bring down the next figure from the dividend, making 22. There are no 25's in 22, hence $22 \div 25$ gives 0. Write 0 in the quotient. Bring down the 8.

To get the last quotient figure, divide 22 by 2, which gives 11. 11 must be wrong because the next quotient figure must be a single figure; hence try 9, which is the largest single figure below 11. When the rule gives 10 or 11 as a quotient figure, always try 9.

The quotient is 109, with a remainder of 3.

Hence 109 rows are filled, and 3 children are left over.

$$\begin{array}{r} 109 \\ 25\overline{)2728} \\ 25 \\ \hline 228 \\ 225 \\ \hline 3 \end{array}$$

Exercises

Divide and check. Watch out for the zeros:

1. $6798 \div 22$	**7.** $6018 \div 29$	**13.** $16{,}340 \div 43$
2. $7290 \div 81$	**8.** $7675 \div 25$	**14.** $16{,}096 \div 32$
3. $7313 \div 71$	**9.** $5014 \div 46$	**15.** $29{,}640 \div 76$
4. $7696 \div 37$	**10.** $7107 \div 69$	**16.** $44{,}856 \div 89$
5. $9328 \div 88$	**11.** $7800 \div 52$	**17.** $69{,}720 \div 83$
6. $8235 \div 27$	**12.** $1011 \div 98$	**18.** $15{,}990 \div 39$

BUYING IN LARGE QUANTITIES

1. Our class bought 36 flags for \$4.32 for a celebration. How much did each flag cost?

Divide dollars and cents just as you divide any other numbers. Always write the *first* figure of the quotient over the *last* figure of the partial dividend; thus, write 1 in the quotient over the 3 of 43. Then place the decimal point in the quotient directly above the decimal point in the dividend.

$$\begin{array}{r} \$\ .12 \\ 36\overline{)\$4.32} \\ 36 \\ \hline 72 \\ 72 \\ \hline \end{array}$$

Each flag cost \$.12. To check, multiply \$.12 by 36.

2. Vera's mother bought a 25-trip railroad ticket to Cobb for \$26.50. How much was the fare for each trip?

3. Peggy's father takes the train to the city every morning. He buys a commutation ticket for a month for \$10.26. If he makes 54 trips on the ticket, how much does he pay for each trip? How much cheaper, for the month, is this than buying single-trip tickets at \$.28 each?

4. A school needs 85 tons of coal this winter. The entire 85 tons can be bought for \$1027.65. If one ton is bought at a time, the price is \$13.60 per ton. How much per ton is saved by buying all the coal at one time?

5. In the Emerson School, 48 children want fountain pens. If the 48 pens are ordered together, they cost \$62.40. Each pen, if bought separately, costs \$1.49. How much is saved on each pen if they are ordered together?

6. Tickets to Woodlands usually cost \$.25 each. Our class hired a bus which took 25 children there for \$5.00. How much did we save on each fare?

7. If 6 doz. golf balls cost \$39.60, how much does 1 golf ball cost?

DIVISORS OF THREE FIGURES

For a pageant our school made 216 costumes at a total cost of $36.85. Find the average cost per costume.

1. To find the average cost, divide $36.85 by 216.

2. To divide by 216, use the same method as for a 2-figure divisor like 21. To estimate each quotient figure, divide by 2. Since $3 \div 2$ gives 1, try 1 as the first quotient figure. Why is 1 right?

3. Explain how you find the second quotient figure.

The average cost per costume was a little over $.17.

$$
\begin{array}{r}
\$\ .17 \\
216\overline{)\$36.85} \\
\underline{21\,6} \\
15\,25 \\
\underline{15\,12} \\
13
\end{array}
$$

If the divisor were 286 instead of 216, you would divide by **3** to estimate each quotient figure, because 286 is close to 300. Since the second figure of 286 is 8, the first figure, 2, is made 1 larger.

If the second figure of any divisor is 5 *or less, divide by the first figure of the divisor to estimate the quotient figures. If the second figure of the divisor is* 6 *or more, divide by* 1 *more than the first figure.*

Exercises

Before dividing, tell what number you will use as a trial divisor. Check your work:

1. $9763 \div 751$	**11.** $8627 \div 359$	**21.** $96{,}959 \div 453$
2. $8834 \div 398$	**12.** $8928 \div 288$	**22.** $26{,}008 \div 627$
3. $9112 \div 536$	**13.** $9702 \div 462$	**23.** $19{,}397 \div 496$
4. $9888 \div 412$	**14.** $9288 \div 344$	**24.** $41{,}577 \div 585$
5. $7176 \div 276$	**15.** $91{,}437 \div 431$	**25.** $55{,}590 \div 654$
6. $7880 \div 394$	**16.** $75{,}969 \div 207$	**26.** $34{,}424 \div 662$
7. $8132 \div 428$	**17.** $47{,}336 \div 776$	**27.** $12{,}150 \div 485$
8. $9743 \div 687$	**18.** $80{,}496 \div 387$	**28.** $87{,}712 \div 896$
9. $9697 \div 418$	**19.** $72{,}127 \div 913$	**29.** $224{,}991 \div 641$
10. $9118 \div 375$	**20.** $99{,}348 \div 487$	**30.** $100{,}492 \div 518$

IMPROVEMENT TEST NO. 3

Test 3 A — Division (Time 4 min.)

1. 2)1428	2. 3)1674	3. 7)6342	4. 9)9027
5. 4)1964	6. 4)2667	7. 7)2205	8. 6)4003
9. 3)2892	10. 5)3717	11. 6)2934	12. 8)7139
13. 9)8532	14. 5)1346	15. 2)1786	16. 8)3565

Test 3 B — Multiplication (Time 5 min. after copying)

1. 637 76	2. 654 28	3. 643 93	4. 460 92
5. 708 48	6. 582 96	7. 632 75	8. 943 84

Test 3 C — Division (Time 4 min. after copying)

1. 63)1512	2. 42)3150	3. 59)2006
4. 71)4473	5. 39)3471	6. 78)4389

Test 3 D — Division (Time 4 min. after copying)

1. 74)4588	2. 41)3321	3. 25)1550
4. 39)2067	5. 53)4028	6. 87)5494

NOTE. For directions for taking the above tests, see page 12.

USES FOR DIVISION

Check your answers in all these problems.

1. Mr. Fall used 18 gal. of gasoline on a 252-mile trip. He wants to know how many miles his automobile goes on 1 gal. Can you tell him?

2. The Woolworth Building in the city of New York is 792 ft. high. Jack's house is 72 ft. high. How many times as high as Jack's house is the Woolworth Building?

3. The De Witt Boat Club has 37 members. They buy a second-hand motor boat for $203.50. How much is each member's share of the cost?

4. Yesterday 234 children had lunch in our school lunch room. They spent $39.78 in all. What was the average cost of each lunch?

5. Ted wants to buy a bicycle costing $24.75. If he saves $2.75 a month, in how many months will he save enough to buy the bicycle?

Before dividing, change $2.75 to 275¢ and $24.75 to 2475¢.

6. Last year Fred's big brother worked 39 weeks at Best's Grocery. He earned $721.50 in all. Find his average weekly earnings.

7. Nancy's father worked 296 days last year. He earned $1850.00. How much did he earn per day? Find the answer in dollars and cents.

8. At $732 each, how many automobiles can a dealer buy for $15,000? How much will he have left over?

9. If you put 144 candies in each jar, how many jars can you fill with 5050 candies? How many candies will be left over?

WORKING PROBLEMS MENTALLY

Celia sells 4 boxes of berries at 26¢ a box. About how much will she get for them?

You know that $4 \times 25¢ = \$1$. Since 26¢ is a little larger than 25¢, Celia will get a little more than \$1 for the 4 boxes of berries.

Exercises

Estimate the answers in these problems mentally.

1. If you think of 27¢ as about 25¢, about how much is $2 \times 27¢$? $3 \times 27¢$? $4 \times 27¢$?

2. Joan has 50¢. If she uses it to buy phonograph records at 23¢ each, how many records can she buy? Will she have any money left?

3. Jack sells 5 dozen eggs at 49¢ a dozen. Remembering that 49¢ is almost 50¢, tell about how much Jack receives for the eggs. Is the exact answer larger or smaller than the answer you estimated?

4. Edna, Frank, and Albert are each receiving a new bicycle from their father. Estimate the cost of the 3 bicycles at \$19.75 each. How does your estimate compare with the exact cost?

Consider \$19.75 as almost \$20.

5. Our class is buying 30 geographies at 98¢ each. Fred estimates that they will cost about \$3 in all. Lydia estimates \$30, and Mary estimates \$20. Whose estimate is best?

6. How many new uniforms can the Bedford baseball team buy with \$45 if the uniforms cost \$8.75 each?

7. Carl and his 3 brothers are going to a football game. The tickets cost 55¢ each. Will \$2 pay for them?

TESTING ANSWERS

A scout troop was buying 6 flashlights at \$1.12 each. Bill thought that they would cost \$67.20. Henry said that this was impossible; for since 1 flashlight would cost a little more than \$1, 6 flashlights would cost a little more than \$6. Bill did the problem again and found the exact cost to be \$6.72. Was Henry's estimate helpful?

Always make a rough mental estimate of the answer before you work the problem on paper. This will tell you whether your final answer is sensible.

Exercises

1. Tony sells Mr. Carr a basket of cherries for 98¢, a basket of peaches for 89¢, and a basket of apples for 85¢. Should he be paid more or less than \$3? Find exactly how much more or less.

2. Dolly is buying a new dress for \$7.98 and a hat for \$2.98. Will a 10-dollar bill pay for both? Estimate how much change she will receive if she gives the clerk \$15. Then find the exact amount of change.

In problems 3 *to* 5, *first estimate the answer roughly. Then find the exact answer.*

3. In a parade there were 15 companies of 110 children each. How many children marched?

4. John spent \$19.79 for seed and fertilizer for his garden. He grew flowers and vegetables which he sold for \$40.26. How much did he make on his garden?

5. Agnes is going from Washington, D. C., to Chicago, a distance of 817 mi. The train travels 43 mi. an hour. How long will it take Agnes to reach Chicago?

ARE YOU A GOOD THINKER?

First tell what the problem asks you to find. Then decide how to find it. When possible, estimate the answer roughly in advance.

1. Walter buys a can of peas for 21¢, a pound of butter for 43¢, and a dozen eggs for 49¢. He gives the clerk $2. How much change should he get?

2. Father picked 924 peaches. He sold 108 of them. The rest mother preserved in jars containing 8 peaches each. How many jars did that make?

3. The boys in our school made 40 bird houses at a cost of $.48 each. They sold them at $1 each. What was their total profit on all the bird houses?

4. Ben's allowance is 25¢ a week. When his father went away on a business trip, he gave Ben a nickel, 2 dimes, a quarter, a half dollar, and a 1-dollar bill. How many weeks' allowance was that?

5. Lena is saving to buy her mother an electric iron costing $3.95 for Christmas, which is 13 weeks off. If she saves 10¢ a week on moving pictures and 20¢ a week on candy, how much more will she need to buy the iron?

6. The girls in our school are dressing dolls for Christmas. We buy 48 dolls at $1.06 each, 15 yd. of voile at 39¢ a yard, and 25 yd. of ribbon at 19¢ a yard. How much do the dolls and their dresses cost in all?

7. If our school orders 48 school pins at a time, they will cost $31.20 in all. If only 27 pins are ordered, they will cost $19.98. How much less will each pin cost if the larger order is given?

THE FARMS OF THE UNITED STATES

1. In an agricultural magazine Dick saw the statement that the United States contained 955,863,715 acres of farm land one year. Dick read the number *955 million, 863 thousand, 715.*

A large number like this is divided by commas into groups, or **periods,** of three figures each, beginning at the right. The first group is the *units' period,* the second is the *thousands' period,* and the third is the *millions' period.*

Millions	Thousands	Units
955,	863,	715

2. Dick read that the total number of farms in the United States was 6,448,343 in a certain year and 6,372,263 five years later. Read these numbers. Was the number of farms increasing or decreasing?

Read statements 3 *to* 7 *about the farms of our country:*

3. In a certain year there were 2,146,362 automobiles and 246,083 tractors on the farms.

4. About 2,500,000 of the farms had telephones.

5. Only 643,900 of the farms had running water in the house and 452,620 had gas or electric light.

6. There were 3,194,000 laborers on the farms in a certain year and 3,085,000 laborers in the following year.

7. There were 31,134,000 people living on the farms of this country in a recent year and 30,655,200 people on farms in the following year.

8. From statements 6 and 7 above, tell whether the number of farm laborers and of people living on the farms of the United States was increasing or decreasing.

READING ROMAN NUMERALS

The Romans wrote numbers by means of the following letters, whose values were as indicated below:

I	V	X	L	C	D	M
1	5	10	50	100	500	1000

When two Roman numerals stand side by side, read them according to these rules:

1. If the letters are alike or if the first letter has a greater value than the second, add them.

Thus, XX = 10 + 10, or 20; DC = 500 + 100, or 600.

2. If the first letter has a smaller value than the second, subtract the first from the second.

Thus, XL = 50 − 10, or 40. CD = 500 − 100, or 400. 900 may be written as CM or as DCCCC.

Exercises

1. The first page of the preface of a large dictionary is numbered I and the last page of the preface is numbered LXXXV. How many pages are there in the preface?

Read these numbers:

2. XXV	**5.** LXIV	**8.** CCCIII	**11.** MCDXCII
3. XIX	**6.** LXXI	**9.** CDLVI	**12.** MDCCCCV
4. XLV	**7.** XCIX	**10.** MDCCC	**13.** MCMXXIX

14. What Roman numeral is seen on some nickels?

15. The cornerstone of the Capitol building in Washington was laid in MDCCXCIII. What year was that?

16. Look for Roman numerals in the chapter headings of books and on the cornerstones of churches and public buildings and tell the class about them.

FRACTIONS

Finding Parts of One Thing

1. Arthur divides an apple into 4 equal parts. What do you call 1 part of the apple? 3 parts?

Write three fourths like this: $\frac{3}{4}$.

2. This pie is divided into 6 equal parts. What do you call 1 part? 5 parts?

Five sixths is written like this: $\frac{5}{6}$.

3. Below is shown $\frac{3}{4}$ of an apple. What part of a pie is shown? what part of a cake?

4. In the fraction $\frac{5}{8}$, 5 is the **numerator** and 8 is the **denominator.** 5 and 8 are the **terms** of the fraction.

$$\frac{5 = \text{numerator}}{8 = \text{denominator}}$$

The denominator 8 shows that 1 whole thing has been divided into 8 equal parts. The numerator 5 shows that 5 of these parts have been taken.

Tell what each numerator and each denominator means:

5. $\frac{1}{2}$ of a pie $\frac{3}{4}$ of a foot $\frac{5}{6}$ of a melon

6. $\frac{2}{3}$ of a cake $\frac{4}{5}$ of a garden $\frac{3}{8}$ of a yard

FINDING PARTS OF A GROUP OF THINGS

1. Ida has 15 daisies. She divides them into 5 equal bunches. What part of all the daisies is 1 bunch? 2 bunches? 3 bunches?

2. You see that $\frac{1}{5}$ of 15 is 3. How many are $\frac{2}{5}$ of 15? $\frac{3}{5}$ of 15? $\frac{4}{5}$ of 15?

3. There are 28 children in Mary's class. The teacher divides them into 4 equal teams. What part of the class is 1 team? 2 teams? 3 teams?

4. On page 38 you saw that $\frac{3}{4}$ can stand for a *part of one thing*, like $\frac{3}{4}$ of an apple. $\frac{3}{4}$ can also stand for a *part of a group of things*, like $\frac{3}{4}$ of 28 boys.

5. To find how many $\frac{3}{4}$ of 28 boys are, think:

$\frac{1}{4}$ of 28 boys = 7 boys
$\frac{3}{4}$ of 28 boys = 3×7 boys, or 21 boys

Exercises

1. There are 16 oz. in 1 lb. How many ounces are there in $\frac{1}{4}$ lb.? in $\frac{3}{4}$ lb.? in $\frac{1}{8}$ lb.? in $\frac{5}{8}$ lb.?

2. How much will $\frac{3}{4}$ lb. of tea cost at 60¢ a pound?

3. How many inches are there in $\frac{1}{4}$ yd.? in $\frac{3}{4}$ yd.?

4. How much will $\frac{3}{4}$ yd. of ribbon cost at 48¢ a yard?

Find the following:

5. $\frac{1}{3}$ of 18	**6.** $\frac{1}{4}$ of 32	**7.** $\frac{1}{6}$ of 24	**8.** $\frac{1}{8}$ of \$1.60
$\frac{2}{3}$ of 18	$\frac{3}{4}$ of 32	$\frac{5}{6}$ of 24	$\frac{3}{8}$ of \$1.60
9. $\frac{1}{5}$ of 35	**10.** $\frac{1}{9}$ of 63	**11.** $\frac{1}{8}$ of 72	**12.** $\frac{1}{3}$ of \$1.20
$\frac{2}{5}$ of 35	$\frac{2}{9}$ of 63	$\frac{5}{8}$ of 72	$\frac{2}{3}$ of \$1.20
$\frac{3}{5}$ of 35	$\frac{5}{9}$ of 63	$\frac{7}{8}$ of 72	$\frac{3}{4}$ of \$1.20

BARGAINS AT THE TOY SHOP

MURRAY'S TOY STORE

IMPORTANT AFTER-CHRISTMAS SALE

REDUCTIONS FROM REGULAR PRICES

$\frac{1}{2}$ Off on All Sleds and Skates
$\frac{1}{3}$ Off on All Books
$\frac{1}{4}$ Off on All Other Things

1. Tom read the above advertisement in a newspaper and said that it was a good chance to buy things cheap. Before Christmas he had seen a sailboat marked \$4.80. At $\frac{1}{4}$ off, what is its price now?

$\frac{1}{4}$ of \$4.80 is \$1.20. Hence \$1.20 is taken off the regular price. Subtracting \$1.20 from \$4.80 without rewriting the numbers, you get \$3.60 as the price now.

4)\$4.80
\$1.20
\$3.60

2. An electric train was marked \$9.60 before Christmas. How much does it cost now? Read the advertisement to find out how much to take off.

3.* Before Christmas Clara had seen a girl's bicycle marked \$24.80. For how much can she buy it now?

Find the prices after $\frac{1}{2}$ is taken off each price:

4. Hockey Skates . . \$4.00 **5.** Boy's Sled . . \$5.00

Find the prices after $\frac{1}{4}$ is taken off each price:

6. Sailboat . . . . \$5.00 **7.** Dolls' Bed . . \$2.40

Find the prices after $\frac{1}{3}$ is taken off each price:

8. Poems for Girls . \$1.35 **9.** Boys' Handbook \$2.25

CAN YOU DIVIDE 3 APPLES AMONG 4 BOYS?

Alice is dividing 3 apples equally among 4 boys. What part of an apple does each boy get?

$3 \div 4 = \frac{3}{4}$

You must find what $3 \div 4$ means. If Alice had only 1 apple to divide among 4 boys, each boy would get $\frac{1}{4}$ of an apple. Since she has 3 apples, each boy gets 3 times as much, or $\frac{3}{4}$ of an apple.

This shows that if 3 *things* are divided into 4 equal parts, each part equals $\frac{3}{4}$ of *one* thing. Thus, $3 \div 4 = \frac{3}{4}$. When you write $3 \div 4$ as $\frac{3}{4}$, the line between the numerator and the denominator means "divided by."

You now have a new use for a fraction.

A fraction can be used to indicate division. It then shows that its numerator is to be divided by its denominator.

Thus, $\frac{5}{6} = 5 \div 6$, $\frac{18}{5} = 18 \div 5$, $\frac{2}{3} = 2 \div 3$.

Exercises

Tell what part of a cake each child gets:

1. If 1 cake is divided equally among 3 boys.

2. If 2 cakes are divided equally among 3 boys.

3. If 1 cake is divided equally among 6 girls.

4. If 5 cakes are divided equally among 6 girls.

5. If 2 cakes are divided equally among 5 girls.

6. Since $6 \div 1 = 6$, you can also write 6 in the form of a fraction, thus: $\frac{6}{1}$. Likewise $15 = \frac{15}{1}$ and $1 = \frac{1}{1}$.

Write each of the following as a fraction:

7. $7 \div 8$	**10.** $7 \div 1$	**13.** $16 \div 5$	**16.** 5
8. $2 \div 3$	**11.** $20 \div 5$	**14.** $27 \div 9$	**17.** 8
9. $1 \div 2$	**12.** $10 \div 2$	**15.** $18 \div 1$	**18.** 2

FOUR WAYS OF EXPRESSING DIVISION

1. Uncle Ben was dividing 95 by 5. He asked Edna in how many different ways she could write this problem. This is what Edna wrote. Was she right?

$95 \div 5$ $\quad$ $5\overline{)95}$ $\quad$ $\frac{1}{5}$ of 95 $\quad$ $\frac{95}{5}$ (new way)

Write each of the following in three other ways:

2. $27 \div 4$ $\quad$ **3.** $18 \div 5$ $\quad$ **4.** $3\overline{)18}$ $\quad$ **5.** $7\overline{)25}$ $\quad$ **6.** $\frac{1}{7}$ of 56 $\quad$ **7.** $\frac{1}{9}$ of 75 $\quad$ **8.** $\frac{81}{9}$ $\quad$ **9.** $\frac{16}{4}$

10. Ruth says that any number divided by itself is always equal to 1. Is Ruth right? Does $\frac{5}{5} = 1$?

11. Tell what each of these equals: $\frac{7}{7}$; $\frac{3}{3}$; $\frac{4}{4}$; $\frac{9}{9}$.

WRITING THE REMAINDER AS A FRACTION

1. Edward has 55 in. of felt with which to make 4 school banners. How long does he make each?

Dividing 55 by 4, you get a quotient of 13, with a remainder of 3. Hence there are 3 in. still to be divided by 4. Since you learned on page 41 that $3 \div 4 = \frac{3}{4}$, you may write $\frac{3}{4}$ after 13.

$4\overline{)55}$

$13\frac{3}{4}$

Each banner is $13\frac{3}{4}$ in. long.

Whenever you have a remainder in a division problem, you can write the remainder over the divisor, thus making a fraction in the quotient.

2. Divide 14 yd. of ribbon equally among 3 girls. How many yards does each girl get?

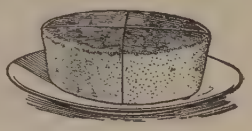
Divide. Write the remainder over the divisor so as to make a fraction in the quotient:

3. $2\overline{)27}$ $\quad$ **4.** $4\overline{)33}$ $\quad$ **5.** $3\overline{)43}$ $\quad$ **6.** $4\overline{)63}$ $\quad$ **7.** $8\overline{)95}$ $\quad$ **8.** $6\overline{)83}$ $\quad$ **9.** $5\overline{)323}$ $\quad$ **10.** $8\overline{)435}$ $\quad$ **11.** $4\overline{)159}$ $\quad$ **12.** $3\overline{)224}$

PROPER AND IMPROPER FRACTIONS

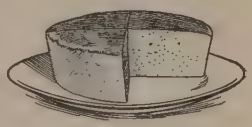
1. A whole thing, like a whole cake, is 1 *unit*, or 1.

2. This cake is divided into quarters. Since 4 quarters make a whole cake, $\frac{4}{4} = 1$. How does the numerator of $\frac{4}{4}$ compare with its denominator?



You can also tell that $\frac{4}{4} = 1$ because $4 \div 4 = 1$.

3. Here you have 3 quarters of a cake. Is $\frac{3}{4}$ more or less than 1? Is the numerator of $\frac{3}{4}$ more or less than its denominator?



4. In the problems above, you have a whole cake divided into 4 quarters, and 3 quarters of another cake. How many quarters of a cake have you in all? Is $\frac{7}{4}$ more or less than 1? Is the numerator of $\frac{7}{4}$ more or less than its denominator?

5. Draw a line $\frac{7}{8}$ in. long. Also draw one $\frac{9}{8}$ in. long. Which is smaller than 1 in.? Which is larger than 1 in.?

Fractions like $\frac{3}{4}$ and $\frac{7}{8}$, in which the numerator is smaller than the denominator, are called **proper fractions.**

Fractions like $\frac{4}{4}$ and $\frac{9}{8}$, in which the numerator is equal to or larger than the denominator, are called **improper fractions.**

A proper fraction is always smaller than 1. An improper fraction equals 1 if the numerator equals the denominator, as in $\frac{4}{4}$. It is larger than 1 if the numerator is larger than the denominator, as in $\frac{9}{8}$.

6. Name the proper and the improper fractions below:

$\frac{3}{5}$ $\frac{8}{9}$ $\frac{7}{3}$ $\frac{14}{2}$ $\frac{5}{1}$ $\frac{8}{8}$ $\frac{1}{4}$ $\frac{10}{10}$

REDUCING IMPROPER FRACTIONS

1. Dan's mother gives him 5 half oranges to share with his friends. The 5 half oranges make 2 whole oranges and $\frac{1}{2}$ of another orange, or $2\frac{1}{2}$ oranges.

Since $\frac{5}{2} = 5 \div 2$, you can also find that $\frac{5}{2} = 2\frac{1}{2}$ by dividing 5 by 2 and writing the remainder as a fraction in the quotient.

2. Kate has 21 quarters in her bank. Remembering that $\frac{21}{4} = 21 \div 4$, show that she has $5\frac{1}{4}$ dollars.

A number like 2 or 5 is a **whole number.**

A number like $2\frac{1}{2}$ or $5\frac{1}{4}$, consisting of a whole number and a fraction, is a **mixed number.**

To reduce an improper fraction to a whole number or to a mixed number, divide its numerator by its denominator.

Exercises

Reduce to whole numbers or to mixed numbers:

1. $\frac{9}{2}$	**5.** $\frac{15}{2}$	**9.** $\frac{19}{4}$	**13.** $\frac{41}{4}$	**17.** $\frac{31}{6}$	**21.** $\frac{26}{5}$
2. $\frac{5}{5}$	**6.** $\frac{17}{8}$	**10.** $\frac{21}{8}$	**14.** $\frac{50}{5}$	**18.** $\frac{25}{6}$	**22.** $\frac{45}{9}$
3. $\frac{7}{4}$	**7.** $\frac{30}{2}$	**11.** $\frac{16}{5}$	**15.** $\frac{37}{10}$	**19.** $\frac{25}{8}$	**23.** $\frac{37}{8}$
4. $\frac{14}{3}$	**8.** $\frac{23}{4}$	**12.** $\frac{32}{16}$	**16.** $\frac{41}{8}$	**20.** $\frac{21}{2}$	**24.** $\frac{75}{25}$

25. Jane made 7 boxes of fudge, each containing $\frac{1}{2}$ lb. How many pounds of fudge did she make?

26. Fred has 5 $\frac{1}{2}$-hour periods of arithmetic every week. How many hours of arithmetic per week has he?

27. Tom has 37 quarters. How many dollars is that?

ADDING FRACTIONS WITH THE SAME NAME

1. You can add things only if they have the same name. You can add 3 *balls* and 6 *balls*, but you cannot add 3 *balls* and 6 *tables*, because they are things with different names.

Can you add 5 cents and 7 cents? 8 fish and 4 fish? 6 dogs and 2 pens? 4 roses and 1 book?

2. A fraction has a name like any other thing. The denominator tells its name. Thus, the name of $\frac{5}{8}$ is *eighths*. The numerator, 5, shows that there are 5 *eighths*, just as the 5 in "5 cats" shows how many cats there are.

3. Since 5 eighths and 2 eighths have the same name, you can add $\frac{5}{8}$ and $\frac{2}{8}$, as shown at the right. Thus, $\frac{5}{8} + \frac{2}{8} = \frac{7}{8}$.

Think this:	*Write this:*
5 eighths	$= \frac{5}{8}$
2 eighths	$= \frac{2}{8}$
7 eighths	$\frac{7}{8}$

4. Add the following:

2 fourths	$\frac{2}{4}$	3 eighths	$\frac{3}{8}$	1 third	$\frac{1}{3}$
1 fourth	$\frac{1}{4}$	4 eighths	$\frac{4}{8}$	1 third	$\frac{1}{3}$

Give the name of each fraction and add:

5.	**6.**	**7.**	**8.**	**9.**	**10.**
$\frac{3}{8}$	$\frac{2}{4}$	$\frac{2}{5}$	$\frac{2}{8}$	$\frac{3}{16}$	$\frac{1}{10}$
$\frac{2}{8}$	$\frac{2}{4}$	$\frac{2}{5}$	$\frac{1}{8}$	$\frac{6}{16}$	$\frac{8}{10}$

11. John has 3 quarters in one pocket and 2 quarters in another. How much money has John in both pockets?

Adding $\$\frac{3}{4}$ and $\$\frac{2}{4}$, you get $\$\frac{5}{4}$. What mixed number does the improper fraction $\frac{5}{4}$ equal?

Add. Change the answers to whole or to mixed numbers:

12.	**13.**	**14.**	**15.**	**16.**	**17.**
$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{8}$
$\frac{4}{8}$	$\frac{1}{4}$	$\frac{4}{8}$	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{7}{8}$

WHAT BILLY DID AT CAMP

1. Last summer Billy went to High Hills Camp. One day he walked $3\frac{1}{4}$ mi. to Clover Lake; then he walked $1\frac{3}{4}$ mi. around the lake and $3\frac{1}{4}$ mi. back to camp. How many miles did he walk in all?

Write the numbers as shown here.

Think "$\frac{1}{4} + \frac{3}{4} + \frac{1}{4} = \frac{5}{4}$, or $1\frac{1}{4}$." Write $\frac{1}{4}$ and carry 1 to the whole numbers. Then think "$1 + 3 + 1 + 3 = 8$." Write 8.

Billy walked $8\frac{1}{4}$ mi. in all.

$$\begin{array}{r} 3\frac{1}{4} \\ 1\frac{3}{4} \\ 3\frac{1}{4} \\ \hline 8\frac{1}{4} \end{array}$$

2. Another day Billy climbed $1\frac{1}{2}$ mi. up Wolf Mountain. He came back along a road $2\frac{1}{2}$ mi. long. How far did he travel that day?

Think "$\frac{1}{2} + \frac{1}{2} = 1$." Carry the 1 to the whole numbers.

Billy walked 4 mi. that day.

$$\begin{array}{r} 1\frac{1}{2} \\ 2\frac{1}{2} \\ \hline 4 \end{array}$$

3. Billy rowed $4\frac{3}{4}$ mi. around Twin Lake, $2\frac{1}{4}$ mi. across the lake, and $2\frac{1}{4}$ mi. back. How far did he row?

Add the following:

4. $\begin{array}{r} 3 \\ 2\frac{1}{4} \\ \hline \end{array}$ **5.** $\begin{array}{r} 2\frac{2}{4} \\ 1\frac{1}{4} \\ \hline \end{array}$ **6.** $\begin{array}{r} 1\frac{1}{2} \\ \frac{1}{2} \\ \hline \end{array}$ **7.** $\begin{array}{r} 2\frac{3}{4} \\ 1\frac{1}{4} \\ \hline \end{array}$ **8.** $\begin{array}{r} 10\frac{1}{2} \\ 2\frac{1}{2} \\ \hline \end{array}$

9. $\begin{array}{r} 2\frac{1}{2} \\ 3\frac{1}{2} \\ \hline \end{array}$ **10.** $\begin{array}{r} 8\frac{1}{4} \\ 2\frac{3}{4} \\ \hline \end{array}$ **11.** $\begin{array}{r} 3\frac{2}{4} \\ 3\frac{3}{4} \\ \hline \end{array}$ **12.** $\begin{array}{r} 5\frac{2}{8} \\ 1\frac{1}{8} \\ \hline \end{array}$ **13.** $\begin{array}{r} 8\frac{1}{2} \\ 5 \\ \hline \end{array}$

14. $\begin{array}{r} 9\frac{1}{4} \\ 3\frac{3}{4} \\ 7 \\ \hline \end{array}$ **15.** $\begin{array}{r} 6\frac{1}{8} \\ 4\frac{3}{8} \\ 5\frac{1}{8} \\ \hline \end{array}$ **16.** $\begin{array}{r} 8\frac{1}{2} \\ 8 \\ 4\frac{1}{2} \\ \hline \end{array}$ **17.** $\begin{array}{r} 2\frac{3}{8} \\ 2\frac{1}{8} \\ 5\frac{3}{8} \\ \hline \end{array}$ **18.** $\begin{array}{r} 2\frac{1}{4} \\ 3\frac{3}{4} \\ 1\frac{1}{4} \\ \hline \end{array}$

19. $\begin{array}{r} 2\frac{1}{4} \\ 1\frac{1}{4} \\ 5\frac{1}{4} \\ \hline \end{array}$ **20.** $\begin{array}{r} 9\frac{3}{4} \\ 2\frac{1}{4} \\ 7\frac{3}{4} \\ \hline \end{array}$ **21.** $\begin{array}{r} 3\frac{2}{8} \\ 6\frac{1}{8} \\ 4\frac{5}{8} \\ \hline \end{array}$ **22.** $\begin{array}{r} 2\frac{1}{2} \\ 3\frac{1}{2} \\ 2\frac{1}{2} \\ \hline \end{array}$ **23.** $\begin{array}{r} 7\frac{1}{8} \\ 3\frac{4}{8} \\ 8\frac{6}{8} \\ \hline \end{array}$

COMPARING HALVES AND FOURTHS

1. Jim earns a half dollar and Sam earns 2 quarters. Do they both earn the same amount? Does $\$\frac{1}{2} = \$\frac{2}{4}$?

2. How many halves of this circle are shaded? Show on this circle that $\frac{1}{2} = \frac{2}{4}$.

3. You see that $\frac{1}{2}$ and $\frac{2}{4}$ are always equal; that is, they have the same value. Hence *you can always change* $\frac{1}{2}$ *to* $\frac{2}{4}$ *or* $\frac{2}{4}$ *to* $\frac{1}{2}$ *to help you in working a problem.*

4. Remember these: $\frac{1}{2} = \frac{2}{4}$ $\frac{2}{4} = \frac{1}{2}$

ADDING HALVES AND FOURTHS

1. Ellen had $\frac{1}{2}$ yd. of gingham. Her mother gave her $\frac{3}{4}$ yd. more. How much had she then?

$$\begin{array}{r} \frac{3}{4} = \frac{3}{4} \\ \frac{1}{2} = \frac{2}{4} \\ \hline \frac{5}{4} = 1\frac{1}{4} \end{array}$$

The fractions must have the same name before you can add them. Change $\frac{1}{2}$ to $\frac{2}{4}$ and think "$\frac{2}{4} + \frac{3}{4} = \frac{5}{4}$." Then change $\frac{5}{4}$ to $1\frac{1}{4}$.

Ellen had $1\frac{1}{4}$ yd. of gingham in all.

2. Eva used $1\frac{1}{2}$ lb. of almonds and $1\frac{3}{4}$ lb. of walnuts for candy. How many pounds of nuts did she use in all?

$$\begin{array}{r} 1\frac{1}{2} = 1\frac{2}{4} \\ 1\frac{3}{4} = 1\frac{3}{4} \\ \hline 3\frac{1}{4} \end{array}$$

Explain the work.

Add. Check the work by going over it again:

3. $\frac{5}{4}$, $\frac{1}{2}$

4. $4\frac{3}{4}$, $5\frac{1}{2}$

5. $9\frac{1}{4}$, $8\frac{1}{2}$

6. $1\frac{1}{2}$, $2\frac{1}{4}$

7. $3\frac{1}{2}$, $2\frac{3}{4}$

8. $5\frac{1}{4}$, $4\frac{1}{2}$, $7\frac{1}{4}$

9. $8\frac{1}{4}$, $7\frac{1}{2}$, $5\frac{1}{2}$

10. $6\frac{3}{4}$, $2\frac{1}{2}$, $2\frac{1}{2}$

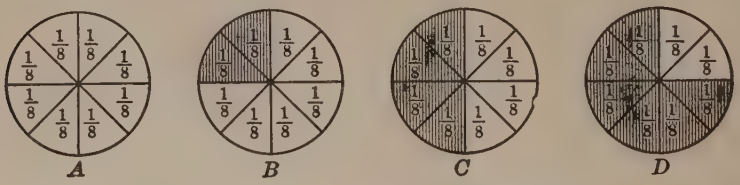
11. $5\frac{3}{4}$, $6\frac{3}{4}$, $2\frac{1}{2}$

12. $7\frac{1}{2}$, $3\frac{3}{4}$, $4\frac{1}{2}$

13. Count by $\frac{1}{4}$'s to 8, like this: $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, etc.

COMPARING HALVES, FOURTHS, AND EIGHTHS

1. Circle *A* is divided into eighths. How many eighths of a circle are there in a whole circle?



2. Study circle *B*. How many eighths of a circle make $\frac{1}{4}$ of a circle? This shows that $\frac{2}{8} = \frac{1}{4}$.

3. Study circle *C*. How many eighths of a circle make $\frac{1}{2}$ of a circle? This shows that $\frac{4}{8} = \frac{1}{2}$.

4. Study circle *D*. How many eighths of a circle make $\frac{3}{4}$ of a circle? This shows that $\frac{6}{8} = \frac{3}{4}$.

5. Since $\frac{1}{2}$ equals $\frac{4}{8}$, you can always change $\frac{1}{2}$ to $\frac{4}{8}$ or $\frac{4}{8}$ to $\frac{1}{2}$. You can also change $\frac{1}{4}$ to $\frac{2}{8}$ and $\frac{3}{4}$ to $\frac{6}{8}$.

6. Remember these because you will use them often:

$\frac{1}{2} = \frac{4}{8}$ $\quad$ $\frac{1}{4} = \frac{2}{8}$ $\quad$ $\frac{3}{4} = \frac{6}{8}$

$\frac{4}{8} = \frac{1}{2}$ $\quad$ $\frac{2}{8} = \frac{1}{4}$ $\quad$ $\frac{6}{8} = \frac{3}{4}$

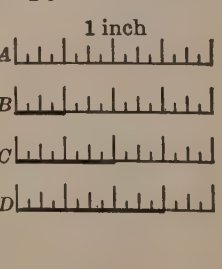
COMPARING FOURTHS AND SIXTEENTHS

1. Draw line *A*, 1 in. long. Divide it into $\frac{1}{16}$'s of an inch.

2. Shade $\frac{1}{4}$ in., as in *B*. Show that $\frac{1}{4}$ in. $= \frac{4}{16}$ in.

3. Shade $\frac{1}{2}$ in., as in *C*. Show that $\frac{1}{2}$ in. $= \frac{8}{16}$ in.

4. Shade $\frac{3}{4}$ in., as in *D*. Show that $\frac{3}{4}$ in. $= \frac{12}{16}$ in.



REDUCING FRACTIONS TO LOWEST TERMS

1. You know that you can change $\frac{4}{8}$ to $\frac{1}{2}$ because $\frac{4}{8}$ and $\frac{1}{2}$ have the same value. A quick way to change $\frac{4}{8}$ to $\frac{1}{2}$ is to divide both terms of $\frac{4}{8}$ by 4, as shown in *A*.

A. $\frac{4 \div 4}{8 \div 4} = \frac{1}{2}$ *B.* $\frac{10 \div 2}{16 \div 2} = \frac{5}{8}$

2. To change $\frac{10}{16}$ to $\frac{5}{8}$, divide its terms by 2, as in *B*.

If you divide both terms of a fraction by the same number, you get another fraction having the same value.

In changing $\frac{4}{8}$ to $\frac{1}{2}$, you reduce $\frac{4}{8}$ to its **lowest terms**, because the terms of $\frac{1}{2}$ cannot be made smaller without changing its value. If you change $\frac{4}{8}$ to $\frac{2}{4}$, you reduce $\frac{4}{8}$ to *lower* terms, but not to *lowest* terms, because $\frac{2}{4}$ can be further reduced to $\frac{1}{2}$.

To reduce a fraction to lowest terms, divide both terms by the largest number that divides both exactly.

Exercises

Reduce each of these fractions to lowest terms:

1. $\frac{8}{16}$	**3.** $\frac{4}{16}$	**5.** $\frac{2}{16}$	**7.** $\frac{10}{16}$	**9.** $\frac{14}{16}$
2. $\frac{2}{8}$	**4.** $\frac{2}{4}$	**6.** $\frac{6}{16}$	**8.** $\frac{6}{8}$	**10.** $\frac{16}{16}$

11. Harry had a board 8 in., or $\frac{8}{12}$ ft., wide. He said that it was $\frac{3}{4}$ ft. wide. What answer would you give?

12. In changing $\frac{8}{16}$ to lowest terms, Ben gave $\frac{4}{8}$ as an answer. Would you give that answer?

13. Tell which of these fractions are not reduced to their lowest terms:

$\frac{4}{16} = \frac{2}{8}$ $\frac{4}{8} = \frac{1}{2}$ $\frac{10}{16} = \frac{5}{8}$ $\frac{12}{16} = \frac{6}{8}$

BETTY SHOPS FOR HER DOGS

1. Betty bought $\frac{5}{8}$ yd. of flannel for a coat for her dog Bubbles and $\frac{5}{8}$ yd. for Fluffy. How much flannel did she buy?

$$\begin{array}{r} \frac{5}{8} \\ \frac{5}{8} \\ \hline \frac{10}{8} = 1\frac{1}{4} \end{array}$$

The sum is $\frac{10}{8}$, or $1\frac{2}{8}$. Reduce $\frac{2}{8}$ to $\frac{1}{4}$.
Betty bought $1\frac{1}{4}$ yd. of flannel.

Always reduce fractions in the answer to lowest terms.

2. Betty bought $\frac{5}{8}$ yd. of ribbon for Bubbles and $\frac{7}{8}$ yd. for Fluffy. How much ribbon did she buy?

3. She bought $1\frac{1}{4}$ yd. of leather for each dog's lead. How many yards of leather did she get in all? Explain the work.

$$\begin{array}{r} 1\frac{1}{4} \\ 1\frac{1}{4} \\ \hline 2\frac{2}{4} = 2\frac{1}{2} \end{array}$$

4. She bought $2\frac{1}{4}$ yd. of cotton blanket cloth for Bubbles and $1\frac{1}{4}$ yd. for Fluffy. How much blanket cloth did she buy?

Exercises

Add. Reduce fractions in sums to lowest terms:

1.	$\frac{2}{8}$	**5.**	$\frac{5}{8}$	**9.**	$\frac{5}{16}$	**13.**	$2\frac{1}{4}$	**17.**	$5\frac{5}{8}$
	$\frac{4}{8}$		$\frac{1}{8}$		$\frac{3}{16}$		$2\frac{1}{4}$		$6\frac{1}{8}$
2.	$\frac{2}{8}$	**6.**	$\frac{7}{8}$	**10.**	$\frac{9}{16}$	**14.**	$5\frac{1}{8}$	**18.**	$6\frac{3}{8}$
	$\frac{2}{8}$		$\frac{3}{8}$		$\frac{9}{16}$		$2\frac{1}{8}$		$9\frac{3}{8}$
3.	$\frac{1}{8}$	**7.**	$\frac{7}{8}$	**11.**	$\frac{1}{16}$	**15.**	$5\frac{7}{16}$	**19.**	$6\frac{7}{16}$
	$\frac{3}{8}$		$\frac{7}{8}$		$\frac{7}{16}$		$7\frac{3}{16}$		$2\frac{1}{16}$
4.	$\frac{1}{4}$	**8.**	$\frac{3}{8}$	**12.**	$\frac{7}{16}$	**16.**	$9\frac{3}{8}$	**20.**	$2\frac{9}{16}$
	$\frac{1}{4}$		$\frac{3}{8}$		$\frac{5}{16}$		$4\frac{1}{8}$		$5\frac{1}{16}$

ORDERING BY MAIL

1. John is ordering by mail articles whose shipping weight is $2\frac{9}{16}$ lb., $1\frac{11}{16}$ lb., and 3 lb. He needs to find their total weight so that he will know how much postage to send. How much do they all weigh?

Adding the fractions, you get $\frac{20}{16}$, which equals $1\frac{4}{16}$, or $1\frac{1}{4}$. Write $\frac{1}{4}$ under the line and carry the 1 to the whole numbers. Then add the whole numbers.

The three articles weigh $7\frac{1}{4}$ lb. in all.

$$\begin{array}{r} 2\frac{9}{16} \\ 1\frac{11}{16} \\ 3 \\ \hline 7\frac{1}{4} \end{array}$$

2. David orders a bat whose shipping weight is $2\frac{1}{2}$ lb., a catcher's mitt weighing $1\frac{1}{4}$ lb., and a fielder's glove weighing $1\frac{1}{2}$ lb. Find the total weight.

3. Mr. Reed orders some things by mail. The catalogue gives their weights as $2\frac{1}{8}$ lb., $1\frac{7}{8}$ lb., $1\frac{5}{8}$ lb., and $3\frac{1}{8}$ lb. How much do they weigh in all?

Exercises

Add. Check the work by going over it again:

1. $2\frac{1}{2}$	**2.** $7\frac{3}{4}$	**3.** $5\frac{7}{8}$	**4.** $9\frac{1}{3}$	**5.** $7\frac{7}{8}$
$4\frac{1}{2}$	$9\frac{1}{4}$	$4\frac{5}{8}$	$2\frac{2}{3}$	$5\frac{3}{8}$
6. $4\frac{3}{16}$	**7.** $4\frac{3}{8}$	**8.** $5\frac{5}{6}$	**9.** $9\frac{3}{12}$	**10.** $1\frac{7}{8}$
$5\frac{11}{16}$	$7\frac{5}{8}$	$4\frac{1}{6}$	$7\frac{5}{12}$	$5\frac{7}{8}$
11. $8\frac{1}{3}$	**12.** $9\frac{1}{8}$	**13.** $2\frac{3}{16}$	**14.** $5\frac{2}{4}$	**15.** $8\frac{1}{2}$
7	$5\frac{7}{8}$	$9\frac{3}{16}$	$4\frac{1}{4}$	7
$5\frac{2}{3}$	$7\frac{3}{8}$	$8\frac{12}{16}$	$9\frac{3}{4}$	$3\frac{1}{2}$
16. $9\frac{1}{3}$	**17.** $4\frac{7}{8}$	**18.** $2\frac{5}{16}$	**19.** $8\frac{3}{4}$	**20.** $1\frac{5}{16}$
2	$8\frac{5}{8}$	9	$4\frac{3}{4}$	$8\frac{7}{16}$
$5\frac{2}{3}$	2	$5\frac{4}{16}$	7	$8\frac{10}{16}$
$3\frac{2}{3}$	$7\frac{3}{8}$	$6\frac{11}{16}$	9	9

A QUICK WAY TO CHANGE $\frac{1}{2}$ TO $\frac{4}{8}$

1. On page 49 you learned how to change $\frac{4}{8}$ to $\frac{1}{2}$ by *dividing* both terms of $\frac{4}{8}$ by 4. A quick way to change $\frac{1}{2}$ back to $\frac{4}{8}$ is to *multiply* both terms of $\frac{1}{2}$ by 4, as shown below in *A*.

A. $\frac{1 \times 4}{2 \times 4} = \frac{4}{8}$ *B.* $\frac{3 \times 2}{4 \times 2} = \frac{6}{8}$

2. In the same way, you can change $\frac{3}{4}$ to $\frac{6}{8}$ by multiplying both terms of $\frac{3}{4}$ by 2, as shown in *B*.

If you multiply both terms of a fraction by the same number, you get another fraction with the same value.

Exercises

1. The quick way to change $\frac{3}{4}$ to $\frac{12}{16}$ is shown here. By what number do you multiply both terms of $\frac{3}{4}$ to get $\frac{12}{16}$? Have $\frac{3}{4}$ and $\frac{12}{16}$ the same value?

$$\frac{3 \times 4}{4 \times 4} = \frac{12}{16}$$

2. By what number do you multiply both terms of $\frac{1}{2}$ to get $\frac{8}{16}$? Have $\frac{1}{2}$ and $\frac{8}{16}$ the same value?

3. Joe says that $\frac{1}{4} = \frac{2}{16}$. Tell why he is wrong.

In each example tell what number should be put in place of the star so that the fractions will be equal:

4. $\frac{1}{8} = \frac{*}{16}$ **5.** $\frac{1}{2} = \frac{*}{8}$ **6.** $\frac{3}{8} = \frac{*}{16}$ **7.** $\frac{1}{2} = \frac{*}{32}$ **8.** $\frac{1}{4} = \frac{*}{32}$

9. $\frac{1}{4} = \frac{*}{8}$ **10.** $\frac{1}{4} = \frac{*}{16}$ **11.** $\frac{5}{8} = \frac{*}{16}$ **12.** $\frac{8}{8} = \frac{*}{16}$ **13.** $\frac{4}{8} = \frac{*}{16}$

14. $\frac{3}{4} = \frac{*}{16}$ **15.** $\frac{3}{4} = \frac{*}{8}$ **16.** $\frac{7}{8} = \frac{*}{16}$ **17.** $\frac{2}{4} = \frac{*}{8}$ **18.** $\frac{2}{8} = \frac{*}{16}$

19. $\frac{4}{4} = \frac{*}{16}$ **20.** $\frac{1}{2} = \frac{*}{4}$ **21.** $\frac{1}{2} = \frac{*}{16}$ **22.** $\frac{5}{8} = \frac{*}{32}$ **23.** $\frac{1}{8} = \frac{*}{32}$

ADDING FRACTIONS WITH DIFFERENT DENOMINATORS

1. You have learned that you can add only things that have the *same name*. Thus, you know at once that 4 *cents* and 5 *cents* are 9 *cents;* but before you can add 4 *cents* and 5 *nickels*, which have different names, you must change the 5 *nickels* to 25 *cents*, as shown at the right. Then you can add 4 cents and 25 cents, which gives 29 cents.

4 cents = 4 cents
5 nickels = 25 cents
29 cents

2. Fred buys $\frac{3}{4}$ lb. of American cheese and $\frac{5}{8}$ lb. of Swiss cheese. How many pounds of cheese is that?

You see that $\frac{3}{4}$ and $\frac{5}{8}$ have different names, one being *fourths* and the other *eighths*. If you change $\frac{3}{4}$ to $\frac{6}{8}$, however, you can add $\frac{6}{8}$ and $\frac{5}{8}$ because they will then have the same name, or the same denominator. The sum is $\frac{11}{8}$, or $1\frac{3}{8}$.

$\frac{3}{4} = \frac{6}{8}$
$\frac{5}{8} = \frac{5}{8}$
$\frac{11}{8} = 1\frac{3}{8}$

Fred buys $1\frac{3}{8}$ lb. of cheese in all.

To add fractions having different denominators, first change them to fractions having the same denominator.

Exercises

1. Ann's mother bought two remnants of the same kind of cloth, one containing $3\frac{1}{4}$ yd. and the other, $2\frac{5}{8}$ yd. How many yards of cloth did she get?

Change the fractions to eighths and add. Check the work by going over it again:

2. $\frac{3}{4}$	**4.** $\frac{3}{8}$	**6.** $\frac{3}{8}$	**8.** $\frac{1}{2}$	**10.** $\frac{7}{8}$	**12.** $\frac{1}{2}$
$\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{5}{8}$	$\frac{1}{4}$	$\frac{7}{8}$
3. $\frac{1}{2}$	**5.** $\frac{1}{8}$	**7.** $\frac{3}{4}$	**9.** $\frac{3}{8}$	**11.** $\frac{1}{4}$	**13.** $\frac{7}{8}$
$\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{3}{4}$

HOW LARGE ARE THESE ORCHARDS?

1. Mr. Scott has $5\frac{1}{2}$ acres of apple trees, $3\frac{1}{4}$ acres of pear trees, and $\frac{3}{8}$ acre of cherry trees. This makes an orchard of how many acres?

$$5\tfrac{1}{2} = 5\tfrac{4}{8}$$
$$3\tfrac{1}{4} = 3\tfrac{2}{8}$$
$$\tfrac{3}{8} = \tfrac{3}{8}$$
$$9\tfrac{1}{8}$$

Since the largest denominator is 8, change $\frac{1}{2}$ to $\frac{4}{8}$ and $\frac{1}{4}$ to $\frac{2}{8}$. $\frac{4}{8} + \frac{2}{8} + \frac{3}{8} = \frac{9}{8}$, or $1\frac{1}{8}$. Write $\frac{1}{8}$ and carry the 1 to the whole numbers.

Mr. Scott has an orchard of $9\frac{1}{8}$ acres.

2. Mr. Scott's neighbor has $1\frac{3}{4}$ acres of apple trees, $10\frac{1}{2}$ acres of peach trees, and $1\frac{5}{8}$ acres of pear trees. How large is his orchard?

3. How many acres do $12\frac{1}{4}$ acres of pear trees, $\frac{1}{2}$ acre of peach trees, and $\frac{5}{8}$ acre of cherry trees make?

Graded Exercises

Change the fractions to eighths and add. Check by going over the work again:

1. $9\frac{1}{2}$	**3.** $2\frac{1}{8}$	**5.** $7\frac{3}{4}$	**7.** $7\frac{5}{8}$	**9.** $8\frac{7}{8}$
$6\frac{1}{2}$	$2\frac{1}{4}$	$5\frac{5}{8}$	$4\frac{1}{4}$	$4\frac{5}{8}$
$5\frac{7}{8}$	$2\frac{1}{2}$	$9\frac{1}{2}$	$5\frac{1}{2}$	$9\frac{1}{2}$
2. $1\frac{3}{8}$	**4.** $8\frac{7}{8}$	**6.** $7\frac{3}{8}$	**8.** $6\frac{1}{2}$	**10.** $3\frac{3}{8}$
$2\frac{1}{4}$	$2\frac{1}{4}$	$5\frac{1}{2}$	$7\frac{1}{8}$	$2\frac{1}{2}$
$7\frac{3}{4}$	$6\frac{1}{2}$	$2\frac{1}{8}$	$9\frac{3}{4}$	$6\frac{5}{8}$

Change the fractions to sixteenths and add:

11. $2\frac{1}{8}$	**13.** $6\frac{3}{8}$	**15.** $4\frac{7}{8}$	**17.** $2\frac{1}{4}$	**19.** $4\frac{1}{2}$
$1\frac{3}{16}$	$4\frac{5}{16}$	$3\frac{5}{16}$	$8\frac{1}{16}$	$3\frac{1}{16}$
12. $4\frac{3}{8}$	**14.** $2\frac{1}{16}$	**16.** $3\frac{1}{16}$	**18.** $5\frac{1}{8}$	**20.** $5\frac{3}{4}$
$2\frac{1}{16}$	$2\frac{1}{4}$	$5\frac{1}{8}$	$5\frac{7}{16}$	$7\frac{5}{16}$

IMPROVEMENT TEST No. 4

Test 4 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.
748	155	686	984	953
696	372	998	948	155
971	681	743	849	130
753	945	715	150	443
462	937	460	885	542
319	368	737	210	226
638	694	279	564	178
823	287	943	798	675

Test 4 B — Subtraction (Time 4 min.)

1. \$484.94 − 357.85	2. \$840.56 − 127.89	3. \$860.50 − 166.59
4. \$683.46 − 393.08	5. \$313.58 − 126.72	6. \$833.36 − 199.16
7. \$630.30 − 134.08	8. \$835.19 − 340.79	9. \$997.04 − 594.50
10. \$885.20 − 677.80	11. \$868.41 − 270.42	12. \$846.11 − 490.61

Test 4 C — Multiplication (Time 4 min. after copying)

1.	2.	3.	4.	5.
2358 × 36	4628 × 95	7692 × 27	9084 × 54	4673 × 38

Test 4 D — Division (Time 5 min. after copying)

1. $93\overline{)69099}$ 2. $85\overline{)64855}$ 3. $48\overline{)23280}$

4. $57\overline{)45903}$ 5. $82\overline{)51865}$

SUBTRACTING FRACTIONS WITH THE SAME NAME

You know that you can add fractions that have the same denominator. You can also subtract fractions that have the same denominator.

Suppose that you have $\frac{7}{8}$ yd. of cloth and use $\frac{3}{8}$ yd. To find how much is left, subtract $\frac{3}{8}$ from $\frac{7}{8}$.

Think of $\frac{7}{8}$ as 7 *eighths* and of $\frac{3}{8}$ as 3 *eighths*. You see that 7 *eighths* less 3 *eighths* are 4 *eighths*, just as 7 *balls* less 3 *balls* are 4 *balls*. Hence $\frac{7}{8} - \frac{3}{8} = \frac{4}{8}$, which equals $\frac{1}{2}$.

You find that $\frac{1}{2}$ yd. of cloth is left.

Think this:	*Write this:*
7 eighths	$= \frac{7}{8}$
3 eighths	$= \frac{3}{8}$
4 eighths	$= \frac{4}{8} = \frac{1}{2}$

Exercises

1. Dick had $\frac{3}{4}$ lb. of copper wire. He sold $\frac{1}{4}$ lb. of it to Sam. How much wire had Dick left?

2. Bert can walk $3\frac{3}{4}$ mi. in an hour. Bob can walk $3\frac{1}{4}$ mi. in the same time. How much farther can Bert walk in an hour than Bob can walk?

3. Anna weighs $68\frac{5}{8}$ lb. Her sister May weighs $74\frac{7}{8}$ lb. How much heavier is May than Anna?

Subtract. Reduce the answers to lowest terms:

4.	$\frac{7}{8}$	**6.**	$\frac{1}{2}$	**8.**	$\frac{5}{16}$	**10.**	$\frac{15}{16}$	**12.**	$\frac{11}{16}$	**14.**	$\frac{9}{8}$
	$\frac{5}{8}$		$\frac{1}{2}$		$\frac{1}{16}$		$\frac{4}{16}$		$\frac{1}{16}$		$\frac{3}{8}$
5.	$\frac{3}{8}$	**7.**	$\frac{5}{8}$	**9.**	$\frac{15}{16}$	**11.**	$\frac{7}{8}$	**13.**	$\frac{11}{8}$	**15.**	$\frac{5}{4}$
	$\frac{1}{8}$		$\frac{2}{8}$		$\frac{3}{16}$		$\frac{1}{8}$		$\frac{5}{8}$		$\frac{3}{4}$

16. How much must you add to each fraction to make 1? Think of 1 as $\frac{2}{2}$ or $\frac{4}{4}$ or $\frac{8}{8}$ or $\frac{16}{16}$.

$\frac{7}{8}$ $\frac{1}{4}$ $\frac{3}{4}$ $\frac{1}{2}$ $\frac{3}{8}$ $\frac{1}{16}$ $\frac{5}{16}$

HOW HEAVY ARE YOUR SCHOOLBOOKS?

1. When Jane weighs herself with her schoolbooks, the scale registers $96\frac{3}{4}$ lb. Without her books she weighs $91\frac{1}{8}$ lb. How much do the books weigh?

Since $\frac{1}{8}$ and $\frac{3}{4}$ have different denominators, you cannot subtract them as they stand. Change $\frac{3}{4}$ to $\frac{6}{8}$. Then subtract $\frac{1}{8}$ from $\frac{6}{8}$, which leaves $\frac{5}{8}$.

You see that Jane's books weigh $5\frac{5}{8}$ lb.

$$\begin{array}{r} 96\frac{3}{4} = 96\frac{6}{8} \\ 91\frac{1}{8} = 91\frac{1}{8} \\ \hline 5\frac{5}{8} \end{array}$$

To subtract fractions with different denominators, first change them to fractions having the same denominator.

2. Philip with his schoolbooks weighs $87\frac{5}{8}$ lb. Philip alone weighs $84\frac{1}{2}$ lb. How heavy are Philip's books? Are his books as heavy as Jane's?

3. Little Dora weighs $47\frac{1}{4}$ lb. With her schoolbooks she weighs $48\frac{7}{8}$ lb. How heavy are her books?

Other Problems

1. John swam across the pool in $44\frac{1}{2}$ sec. Ed did it in $50\frac{3}{4}$ sec. By how many seconds did John beat Ed?

2. A train usually takes $3\frac{1}{4}$ hr. to go from Omaha to the city where Ann lives. Last Sunday the train took $4\frac{1}{2}$ hr. to make this trip. How many hours late was it?

Subtract. Check by going over the work again:

3.	$5\frac{1}{2}$	**6.**	$6\frac{1}{2}$	**9.**	$8\frac{7}{8}$	**12.**	$6\frac{3}{4}$	**15.**	$5\frac{1}{2}$
	$4\frac{1}{4}$		$2\frac{1}{8}$		$7\frac{1}{4}$		$4\frac{3}{8}$		$2\frac{1}{16}$
4.	$9\frac{1}{4}$	**7.**	$8\frac{3}{4}$	**10.**	$5\frac{5}{8}$	**13.**	$7\frac{3}{8}$	**16.**	$9\frac{3}{16}$
	$7\frac{1}{8}$		$3\frac{1}{2}$		$1\frac{1}{2}$		$5\frac{1}{16}$		$8\frac{1}{8}$
5.	$5\frac{1}{2}$	**8.**	$6\frac{7}{8}$	**11.**	$9\frac{3}{8}$	**14.**	$9\frac{7}{8}$	**17.**	$7\frac{1}{2}$
	$3\frac{3}{8}$		$2\frac{1}{2}$		$5\frac{1}{4}$		$3\frac{3}{4}$		$4\frac{5}{16}$

CHANGING MONEY

1. Mr. Jones wanted to give Fred a quarter. He had only a 5-dollar bill, which he changed to 4 dollars and 4 quarters; that is, he changed \$5 to $\$4\frac{4}{4}$. After giving $\$\frac{1}{4}$ to Fred, he had $\$4\frac{3}{4}$ left, because $4\frac{4}{4} - \frac{1}{4} = 4\frac{3}{4}$.

2. Mr. Baker has 4 whole dollars and 1 quarter. He wants to change one of the dollars into quarters. Dora says that he will then have 3 dollars and 5 quarters. Is she right? Does $\$4\frac{1}{4} = \$3\frac{5}{4}$?

Tell what numbers should be put in place of the stars:

3. \$10 equals \$9 and * quarters. Hence $10 = 9\frac{*}{4}$.

4. \$5 equals \$4 and * half dollars. Hence $5 = 4\frac{*}{2}$.

5. $\$7\frac{1}{4}$ equals \$6 and * quarters. Hence $7\frac{1}{4} = 6\frac{*}{4}$.

6. $\$8\frac{1}{2}$ equals \$7 and * half dollars. Hence $8\frac{1}{2} = 7\frac{*}{2}$.

7. $\$5\frac{1}{4}$ equals \$4 and * quarters. Hence $5\frac{1}{4} = 4\frac{*}{4}$.

8. $\$6\frac{1}{4}$ equals \$5 and * quarters. Hence $6\frac{1}{4} = 5\frac{*}{4}$.

9. A dime is * of a dollar. A nickel is * of a dollar.

10. \$5 equals \$4 and * dimes. Hence $5 = 4\frac{*}{10}$.

11. \$3 equals \$2 and * nickels. Hence $3 = 2\frac{*}{20}$.

12. $\$4\frac{1}{10}$ equals \$3 and * dimes. Hence $4\frac{1}{10} = 3\frac{*}{10}$.

What numbers should be put in place of the stars?

13. $7 = 6\frac{*}{4}$

14. $7 = 6\frac{*}{8}$

15. $9 = 8\frac{*}{2}$

16. $9 = 8\frac{*}{8}$

17. $3 = 2\frac{*}{4}$

18. $3 = 2\frac{*}{16}$

19. $9\frac{1}{2} = 8\frac{*}{2}$

20. $8\frac{1}{4} = 7\frac{*}{4}$

21. $5\frac{3}{4} = 4\frac{*}{4}$

22. $9\frac{3}{8} = 8\frac{*}{8}$

23. $5\frac{1}{8} = 4\frac{*}{8}$

24. $3\frac{3}{16} = 2\frac{*}{16}$

25. $5\frac{1}{4} = 5\frac{2}{8} = 4\frac{*}{8}$

26. $8\frac{1}{2} = 8\frac{*}{8} = 7\frac{*}{8}$

27. $6\frac{1}{2} = 6\frac{*}{4} = 5\frac{*}{4}$

28. $4\frac{1}{4} = 4\frac{*}{8} = 3\frac{*}{8}$

29. $7\frac{3}{4} = 7\frac{*}{8} = 6\frac{*}{8}$

30. $3\frac{1}{8} = 3\frac{2}{16} = 2\frac{*}{16}$

GAMES WITH FRACTIONS

Divide the class into two teams, the Reds and the Blues, and play these games. *Do all the work mentally.* If you give an incorrect answer, you must take your seat. The team with the most children standing at the end wins.

1. *Game of 1's.* Fred, the leader, gives the fraction $\frac{2}{3}$. The first child of the Blue team tells how much is added to $\frac{2}{3}$ to make 1. Then Fred gives the fraction $\frac{3}{16}$, and the first Red tells what is added to $\frac{3}{16}$ to make 1. Then Fred tries other fractions.

2. *Changing Money Game.* Mary, the leader, gives a number like $\$3\frac{1}{2}$, which must be changed to $\$2\frac{3}{2}$. Then she gives $\$3\frac{3}{4}$, which must be changed to $\$2\frac{7}{4}$, and so on.

3. *Reduction Match.* The leader gives a fraction like $\frac{3}{4}$ and asks the teams to keep changing it to other fractions having the same value by always multiplying both terms by 2. A Red changes it to $\frac{6}{8}$. Then a Blue changes it to $\frac{12}{16}$. If the next Red changes it to $\frac{24}{30}$, which is wrong, he must sit down. When the terms of the fraction get large, as in $\frac{24}{32}$, the teams start reducing the fraction to lower terms again until they get back to $\frac{3}{4}$. Then they start with another fraction, like $\frac{1}{2}$, and choose a different multiplier, like 3.

Another form of this game is for the leader to say "Change $\frac{3}{4}$ to twelfths" or "Change $\frac{5}{8}$ to sixteenths."

4. *Mental Addition Match.* Make some flash cards each 8 in. long and 6 in. wide. Write one of these fractions on each card: $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$, $\frac{1}{8}$, $\frac{3}{8}$, $\frac{5}{8}$, $\frac{7}{8}$. The leader holds up two of these cards, like $\frac{1}{2}$ and $\frac{3}{4}$, and asks the child whose turn it is to give the sum mentally. Then he shows two other cards.

A CLASS PARTY

1. The children in our class made candy for a party. From a 7-pound package of sugar they used $4\frac{5}{8}$ lb. How much sugar was left?

Since there is no fraction in the minuend 7, you must change 7 to $6\frac{8}{8}$ before you can subtract. Can you subtract $4\frac{5}{8}$ from $6\frac{8}{8}$?

$$7 = 6\frac{8}{8}$$
$$4\frac{5}{8} = 4\frac{5}{8}$$
$$2\frac{3}{8}$$

The children had $2\frac{3}{8}$ lb. of sugar left.

2. The children had $3\frac{1}{4}$ lb. of butter. They used $\frac{3}{4}$ lb. of it for the candy. How much butter had they then?

Since you cannot take $\frac{3}{4}$ from $\frac{1}{4}$, change $3\frac{1}{4}$ to $2\frac{5}{4}$. Then subtract $\frac{3}{4}$ from $2\frac{5}{4}$, which leaves $2\frac{2}{4}$, or $2\frac{1}{2}$.

$$3\frac{1}{4} = 2\frac{5}{4}$$
$$\frac{3}{4} = \frac{3}{4}$$
$$2\frac{2}{4} = 2\frac{1}{2}$$

The children had $2\frac{1}{2}$ lb. of butter left.

3. If the children had $2\frac{3}{8}$ lb. of sugar and used $1\frac{5}{8}$ lb. of it for cocoa, how much sugar was left?

4. If they used $3\frac{1}{2}$ lb. of flour from a 5-pound bag, how much flour was left?

Other Problems

1. May does the 50-yard dash in $8\frac{3}{4}$ sec. and Lucy in $10\frac{1}{4}$ sec. How much longer does Lucy take than May?

2. Ted caught a $3\frac{1}{8}$-pound fish. After it was cleaned, it weighed $2\frac{3}{8}$ lb. How much weight was lost in cleaning?

Subtract. Check the work by going over it again:

3.	10 $5\frac{1}{2}$	**5.**	7 $4\frac{3}{4}$	**7.**	4 $2\frac{1}{8}$	**9.**	$8\frac{1}{8}$ $2\frac{5}{8}$	**11.**	$5\frac{1}{8}$ $2\frac{7}{8}$
4.	9 $6\frac{1}{4}$	**6.**	6 $3\frac{7}{8}$	**8.**	$7\frac{1}{4}$ $4\frac{3}{4}$	**10.**	$6\frac{3}{8}$ $4\frac{7}{8}$	**12.**	$6\frac{3}{16}$ $3\frac{7}{16}$

COMPARING WEIGHTS

1. Clara weighs $65\frac{1}{2}$ lb. Her baby sister weighs $19\frac{3}{4}$ lb. How much more does Clara weigh than the baby?

Since you cannot subtract fourths from halves, change $65\frac{1}{2}$ to $65\frac{2}{4}$. Since you cannot take $\frac{3}{4}$ from $\frac{2}{4}$, change $65\frac{2}{4}$ to $64\frac{6}{4}$. How many are $64\frac{6}{4} - 19\frac{3}{4}$?

Clara weighs $45\frac{3}{4}$ lb. more than the baby.

$$65\tfrac{1}{2} = 65\tfrac{2}{4} = 64\tfrac{6}{4}$$
$$19\tfrac{3}{4} = 19\tfrac{3}{4} = 19\tfrac{3}{4}$$
$$45\tfrac{3}{4}$$

2. Stanley weighs $85\frac{1}{2}$ lb. His brother Orrin weighs $6\frac{3}{4}$ lb. less. How heavy is Orrin?

3. The average weight of the girls in Carrie's class is $72\frac{3}{8}$ lb. Carrie's weight is $67\frac{1}{2}$ lb. How much below the average is her weight?

4. Donald weighs $86\frac{1}{4}$ lb. This is $9\frac{1}{2}$ lb. more than the average weight of the children in his class. Find the average weight of the children in Donald's class.

Graded Exercises

Subtract. Check by going over the work carefully. Arrange the work as in ex. 1 *above:*

1.	$8\frac{1}{4}$ $5\frac{1}{2}$	**5.**	$6\frac{1}{8}$ $1\frac{1}{2}$	**9.**	$9\frac{1}{4}$ $5\frac{7}{8}$	**13.**	$9\frac{1}{2}$ $1\frac{3}{8}$	**17.**	$24\frac{7}{16}$ $3\frac{1}{2}$
2.	$7\frac{1}{8}$ $4\frac{1}{4}$	**6.**	$7\frac{1}{8}$ $5\frac{3}{4}$	**10.**	$9\frac{3}{4}$ $2\frac{7}{8}$	**14.**	$8\frac{1}{16}$ $2\frac{1}{2}$	**18.**	$45\frac{1}{2}$ $23\frac{9}{16}$
3.	$8\frac{1}{2}$ $2\frac{3}{4}$	**7.**	$5\frac{1}{2}$ $3\frac{7}{8}$	**11.**	$7\frac{1}{2}$ $3\frac{5}{8}$	**15.**	$7\frac{1}{8}$ $3\frac{3}{16}$	**19.**	$69\frac{1}{4}$ $55\frac{5}{16}$
4.	$7\frac{1}{4}$ $3\frac{3}{8}$	**8.**	$6\frac{3}{8}$ $4\frac{1}{2}$	**12.**	$8\frac{1}{4}$ $7\frac{5}{8}$	**16.**	$8\frac{1}{8}$ $7\frac{7}{16}$	**20.**	$53\frac{1}{8}$ $39\frac{5}{16}$

HALVES, THIRDS, AND SIXTHS

1. How many inches are there in $\frac{1}{2}$ yd.? in $\frac{3}{6}$ yd.? This shows that $\frac{1}{2}$ yd. = $\frac{3}{6}$ yd.

2. How many inches are there in $\frac{1}{3}$ yd.? in $\frac{2}{6}$ yd.? This shows that $\frac{1}{3}$ yd. = $\frac{2}{6}$ yd.

3. How many inches are there in $\frac{2}{3}$ yd.? in $\frac{4}{6}$ yd.? This shows that $\frac{2}{3}$ yd. = $\frac{4}{6}$ yd. By what number do you multiply both terms of $\frac{2}{3}$ to show quickly that $\frac{2}{3} = \frac{4}{6}$?

4. How many eggs are there in $\frac{2}{3}$ doz.? in $\frac{8}{12}$ doz.? This shows that $\frac{2}{3}$ doz. = $\frac{8}{12}$ doz. How can you change $\frac{2}{3}$ to $\frac{8}{12}$ quickly without finding parts of a dozen?

Exercises

In ex. 1 *to* 8, *by what do you multiply both terms of the first fraction to change it to the second fraction?*

1. $\frac{1}{3} = \frac{2}{6}$ **3.** $\frac{1}{2} = \frac{3}{6}$ **5.** $\frac{2}{3} = \frac{8}{12}$ **7.** $\frac{1}{6} = \frac{2}{12}$

2. $\frac{2}{3} = \frac{4}{6}$ **4.** $\frac{1}{3} = \frac{4}{12}$ **6.** $\frac{1}{2} = \frac{6}{12}$ **8.** $\frac{5}{6} = \frac{10}{12}$

9. Mr. Thomas keeps a clothing store. If he wants part of a dozen pairs of gloves, he writes the order like this: "Send me $\frac{3}{12}$ doz. gloves." Write $\frac{3}{12}$ another way. How would Mr. Thomas write $\frac{1}{2}$ doz. caps? $\frac{1}{3}$ doz.? $\frac{2}{3}$ doz.? $\frac{1}{6}$ doz.? $\frac{5}{6}$ doz.? $\frac{3}{4}$ doz.?

10. What part of a foot is 4 in.? 10 in.? 6 in.?

Reduce the fractions that are not in lowest terms:

11. $\frac{2}{6}$ $\frac{10}{12}$ $\frac{3}{6}$ $\frac{3}{12}$ $\frac{4}{6}$ $\frac{6}{12}$ $\frac{11}{12}$

12. $\frac{5}{6}$ $\frac{8}{12}$ $\frac{1}{6}$ $\frac{9}{12}$ $\frac{2}{3}$ $\frac{4}{12}$ $\frac{5}{12}$

13. Count by $\frac{1}{6}$'s to 5, thus: $\frac{1}{6}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{5}{6}$, 1, $1\frac{1}{6}$, etc.

14. Remember these: $\frac{2}{6} = \frac{1}{3}$ $\frac{3}{6} = \frac{1}{2}$ $\frac{4}{6} = \frac{2}{3}$

ADDING HALVES, THIRDS, AND SIXTHS

Arthur works at Mr. Ball's store. Yesterday he sold $6\frac{1}{2}$ doz. black pencils, $3\frac{1}{6}$ doz. red pencils, and $1\frac{2}{3}$ doz. blue pencils. How many dozen pencils was that?

Since $\frac{1}{2}$, $\frac{1}{6}$, and $\frac{2}{3}$ have different denominators, change them to fractions with the same denominator.

$\frac{4}{6} + \frac{1}{6} + \frac{3}{6} = \frac{8}{6}$, which equals $1\frac{2}{6}$. Write $\frac{2}{6}$ and carry 1 to the whole numbers. The result is $11\frac{2}{6}$, which equals $11\frac{1}{3}$.

Arthur sold $11\frac{1}{3}$ doz. pencils in all.

$$\begin{aligned} 6\tfrac{1}{2} &= 6\tfrac{3}{6} \\ 3\tfrac{1}{6} &= 3\tfrac{1}{6} \\ 1\tfrac{2}{3} &= 1\tfrac{4}{6} \\ \hline 11\tfrac{2}{6} &= 11\tfrac{1}{3} \end{aligned}$$

Exercises

1. Jane kept this record of the time she practiced on the piano last week: $1\frac{1}{2}$ hr., $1\frac{2}{3}$ hr., $\frac{5}{6}$ hr., $1\frac{1}{2}$ hr., $1\frac{1}{6}$ hr. How many hours was that in all?

2. Last week Jim helped at the drug store $2\frac{1}{2}$ hr. on Monday, $1\frac{1}{6}$ hr. on Tuesday, and $4\frac{2}{3}$ hr. on Friday. How many hours did he work last week?

Add. Check the work by going over it again:

3. $4\frac{1}{6}$	**4.** $3\frac{1}{2}$	**5.** $6\frac{2}{3}$	**6.** $9\frac{5}{6}$	**7.** $7\frac{1}{2}$
$5\frac{1}{3}$	$2\frac{1}{6}$	$4\frac{1}{6}$	$8\frac{1}{3}$	$7\frac{5}{6}$
8. $7\frac{1}{6}$	**9.** $4\frac{1}{6}$	**10.** $2\frac{1}{2}$	**11.** $8\frac{2}{3}$	**12.** $9\frac{1}{3}$
$5\frac{1}{2}$	$9\frac{2}{3}$	$5\frac{2}{3}$	$4\frac{5}{6}$	$7\frac{1}{2}$
13. $9\frac{1}{6}$	**14.** $8\frac{1}{2}$	**15.** $7\frac{2}{3}$	**16.** $8\frac{5}{6}$	**17.** $9\frac{1}{2}$
$2\frac{1}{6}$	$5\frac{1}{2}$	$6\frac{1}{6}$	$9\frac{1}{3}$	$7\frac{1}{3}$
$4\frac{2}{3}$	$3\frac{1}{6}$	$2\frac{5}{6}$	$4\frac{1}{3}$	$1\frac{1}{6}$
18. $7\frac{1}{2}$	**19.** $1\frac{2}{3}$	**20.** $3\frac{1}{3}$	**21.** $8\frac{1}{3}$	**22.** $9\frac{1}{3}$
$8\frac{5}{6}$	$4\frac{5}{6}$	$2\frac{1}{2}$	$5\frac{1}{6}$	$7\frac{2}{3}$
$2\frac{1}{3}$	$8\frac{1}{2}$	$5\frac{1}{6}$	$6\frac{2}{3}$	$5\frac{1}{2}$

COMPARING RECORDS IN JUMPING

1. In the running broad jump Rose can jump $6\frac{1}{2}$ ft. Little Doris can jump only $4\frac{2}{3}$ ft. How much farther can Rose jump than Doris?

Since you cannot change $\frac{1}{2}$ to *thirds*, change both $\frac{1}{2}$ and $\frac{2}{3}$ to *sixths*.

You find that Rose can jump $1\frac{5}{6}$ ft. farther than Doris.

Check by going over the work carefully.

$$6\tfrac{1}{2} = 6\tfrac{3}{6} = 5\tfrac{9}{6}$$
$$4\tfrac{2}{3} = 4\tfrac{4}{6} = 4\tfrac{4}{6}$$
$$1\tfrac{5}{6}$$

2. The world's champion in the running broad jump jumped $25\frac{5}{6}$ ft. Arthur can jump $11\frac{1}{3}$ ft. How much longer was the champion's jump than Arthur's?

3. In the standing high jump, the champion record is $5\frac{1}{2}$ ft., while in the running high jump it is $6\frac{2}{3}$ ft. Which record is higher, and how much higher?

Exercises in Subtraction

Subtract. Check each answer by going over the work again:

1.	$8\frac{5}{6}$	**5.**	$9\frac{5}{6}$	**9.**	$9\frac{1}{6}$	**13.**	$9\frac{2}{3}$	**17.**	$8\frac{1}{6}$
	$3\frac{1}{6}$		$7\frac{1}{2}$		$1\frac{1}{2}$		$5\frac{1}{2}$		$4\frac{2}{3}$
2.	$7\frac{1}{3}$	**6.**	$8\frac{1}{2}$	**10.**	$7\frac{1}{6}$	**14.**	$6\frac{1}{3}$	**18.**	8
	$1\frac{2}{3}$		$4\frac{1}{6}$		$5\frac{1}{3}$		$3\frac{1}{2}$		$4\frac{1}{6}$
3.	$9\frac{1}{6}$	**7.**	$7\frac{5}{6}$	**11.**	$8\frac{1}{2}$	**15.**	$4\frac{1}{2}$	**19.**	$4\frac{5}{6}$
	$8\frac{5}{6}$		$6\frac{1}{3}$		$2\frac{1}{3}$		$2\frac{2}{3}$		$3\frac{1}{6}$
4.	4	**8.**	$5\frac{5}{6}$	**12.**	7	**16.**	4	**20.**	$2\frac{2}{3}$
	$2\frac{5}{6}$		$3\frac{2}{3}$		$2\frac{2}{3}$		$3\frac{5}{6}$		$1\frac{5}{6}$

HALVES, FIFTHS, AND TENTHS

1. This cake of chocolate is divided into 10 squares. Copy the picture. Show by shading that $\frac{1}{5} = \frac{2}{10}$; that $\frac{1}{2} = \frac{5}{10}$; that $\frac{3}{5} = \frac{6}{10}$. What does $\frac{4}{5}$ equal?

2. How many minutes are there in $\frac{3}{5}$ hr.? in $\frac{6}{10}$ hr.? Does $\frac{3}{5} = \frac{6}{10}$?

3. By what number do you multiply both terms of $\frac{1}{5}$ to show that $\frac{1}{5} = \frac{2}{10}$? How do you change $\frac{3}{5}$ to $\frac{6}{10}$?

Exercises

Tell how the first fraction is changed to the second fraction:

1. $\frac{1}{2} = \frac{5}{10}$ **3.** $\frac{1}{6} = \frac{2}{12}$ **5.** $\frac{3}{5} = \frac{6}{10}$ **7.** $\frac{1}{2} = \frac{10}{20}$

2. $\frac{4}{5} = \frac{8}{10}$ **4.** $\frac{1}{4} = \frac{5}{20}$ **6.** $\frac{2}{5} = \frac{8}{20}$ **8.** $\frac{3}{5} = \frac{60}{100}$

9. Mr. Day's speedometer registers $148\frac{6}{10}$ mi. Sam says that this is equal to $148\frac{1}{2}$ mi. Is Sam right?

10. Will says that 5¢ is $\frac{5}{100}$ of a dollar. Say this in another way by changing $\frac{5}{100}$ to a small fraction.

What word or number should be put in each blank space?

11. To change $\frac{8}{10}$ to $\frac{4}{5}$, ... both terms of $\frac{8}{10}$ by ···

12. To change $\frac{1}{2}$ to $\frac{50}{100}$, ... both terms of $\frac{1}{2}$ by ···

13. To change $\frac{6}{10}$ to $\frac{3}{5}$, ... both terms of $\frac{6}{10}$ by ···

14. To change $\frac{3}{5}$ to $\frac{60}{100}$, ... both terms of $\frac{3}{5}$ by ···

15. To change $\frac{4}{5}$ to $\frac{8}{10}$, ... both terms of $\frac{4}{5}$ by ···

16. To change $\frac{5}{10}$ to $\frac{1}{2}$, ... both terms of $\frac{5}{10}$ by ···

Reduce the fractions that are not in lowest terms:

17. $\frac{3}{10}$ $\frac{8}{12}$ $\frac{4}{6}$ $\frac{7}{12}$ $\frac{20}{50}$ $\frac{8}{20}$ $\frac{4}{5}$

18. $\frac{16}{100}$ $\frac{6}{8}$ $\frac{9}{20}$ $\frac{10}{20}$ $\frac{5}{6}$ $\frac{1}{2}$ $\frac{12}{16}$

A RELAY RACE

In a track meet, four teams ran in the relay race. Each team had four boys on it.

1. The times of the boys on the Dalton team were $7\frac{3}{5}$ sec., $8\frac{4}{5}$ sec., $7\frac{1}{2}$ sec., $8\frac{2}{5}$ sec. What was their total time?

$$\begin{array}{rcl} 7\frac{3}{5} & = & 7\frac{6}{10} \\ 8\frac{4}{5} & = & 8\frac{8}{10} \\ 7\frac{1}{2} & = & 7\frac{5}{10} \\ 8\frac{2}{5} & = & 8\frac{4}{10} \\ \hline & & 32\frac{3}{10} \end{array}$$

The common denominator of halves and fifths is tenths. Hence change each fraction to tenths. $\frac{6}{10} + \frac{5}{10} + \frac{8}{10} + \frac{6}{10} = \frac{25}{10}$, or $2\frac{3}{10}$. Write $\frac{3}{10}$ and carry 2.

The total time was $32\frac{3}{10}$ sec.

2. The times of the four boys on the Westfield team were $7\frac{4}{5}$ sec., $8\frac{1}{5}$ sec., $8\frac{1}{10}$ sec., $7\frac{1}{2}$ sec. What was their total time?

3. The runners on the Midget team made these times: $7\frac{2}{5}$ sec., $8\frac{1}{10}$ sec., $8\frac{1}{2}$ sec., $7\frac{3}{10}$ sec. How long did they take for the race?

4. The times of the Stanwich boys were $7\frac{4}{5}$ sec., $7\frac{7}{10}$ sec., $8\frac{1}{2}$ sec., $8\frac{3}{5}$ sec. Find their total time.

5. Which of the teams in ex. 1 to 4 won the race?

Exercises

Add. Check the work by going over it again:

1.	$4\frac{1}{5}$	**2.**	$2\frac{1}{2}$	**3.**	$7\frac{4}{5}$	**4.**	$5\frac{7}{10}$	**5.**	$2\frac{1}{2}$
	$9\frac{1}{10}$		$8\frac{3}{10}$		$6\frac{1}{10}$		$3\frac{2}{5}$		$4\frac{1}{10}$
6.	$7\frac{1}{2}$	**7.**	$8\frac{4}{5}$	**8.**	$9\frac{3}{5}$	**9.**	$8\frac{1}{2}$	**10.**	$4\frac{1}{2}$
	$4\frac{1}{5}$		$8\frac{1}{2}$		$5\frac{1}{2}$		$3\frac{2}{5}$		$6\frac{4}{5}$
11.	$2\frac{2}{5}$	**12.**	$7\frac{9}{10}$	**13.**	$7\frac{1}{5}$	**14.**	$2\frac{3}{5}$	**15.**	$8\frac{1}{10}$
	$9\frac{1}{5}$		$9\frac{3}{10}$		$5\frac{1}{2}$		$9\frac{1}{2}$		$3\frac{4}{5}$
	$5\frac{7}{10}$		$7\frac{4}{5}$		$3\frac{9}{10}$		$1\frac{3}{10}$		$6\frac{1}{2}$

HALVES, FIFTHS, AND TENTHS

1. Mr. Wood's speedometer read $96\frac{1}{10}$ mi. when he started his trip. After an hour it read $118\frac{1}{2}$ mi. How far did he travel in the hour?

$$118\tfrac{1}{2} = 118\tfrac{5}{10}$$
$$96\tfrac{1}{10} = 96\tfrac{1}{10}$$
$$22\tfrac{4}{10} = 22\tfrac{2}{5}$$

The common denominator is 10. To what fraction do you change $\frac{1}{2}$?

Mr. Wood traveled $22\frac{2}{5}$ mi. in 1 hr.

Check the work by going over it.

2. Dick drives a delivery car. His speedometer registered $89\frac{3}{10}$ mi. on Monday morning and $192\frac{1}{5}$ mi. on Saturday night. How many miles in all did he drive the car during the week?

3. Jim's time for the 100-yard dash is $16\frac{1}{5}$ sec. Roy's time is $15\frac{7}{10}$ sec. Roy runs how much faster than Jim?

4. When Tom first got his bicycle he rode it at $10\frac{1}{5}$ mi. an hour. Now his speed is $14\frac{1}{2}$ mi. an hour. How much has his speed increased?

Subtract the following. Check the work by going over each step again carefully:

5.	$6\frac{4}{5}$	**8.**	$8\frac{1}{10}$	**11.**	$8\frac{3}{10}$	**14.**	$7\frac{2}{5}$	**17.**	$6\frac{1}{2}$
	$4\frac{1}{10}$		$6\frac{2}{5}$		$5\frac{1}{2}$		$2\frac{1}{2}$		$1\frac{1}{5}$
6.	$8\frac{9}{10}$	**9.**	9	**12.**	7	**15.**	$5\frac{3}{5}$	**18.**	$9\frac{1}{2}$
	$3\frac{1}{5}$		$4\frac{1}{5}$		$4\frac{7}{10}$		$3\frac{1}{2}$		$3\frac{3}{5}$
7.	$9\frac{1}{10}$	**10.**	$9\frac{1}{5}$	**13.**	$8\frac{1}{2}$	**16.**	$8\frac{4}{5}$	**19.**	$7\frac{1}{2}$
	$7\frac{1}{5}$		$7\frac{1}{10}$		$7\frac{2}{5}$		$4\frac{1}{2}$		$1\frac{4}{5}$

20. In a class of boys, the best time in the 50-yard dash is $7\frac{3}{10}$ sec.; the poorest time is 9 sec. How much faster is the best record than the poorest one?

FINDING A COMMON DENOMINATOR

When you add $\frac{1}{2}$ and $\frac{5}{8}$, the common denominator, 8, is also the denominator of one of the fractions; but when you add $\frac{1}{2}$ and $\frac{2}{5}$, the common denominator is 10. This denominator is different from the denominator of either fraction. It is a number large enough to contain each of the other denominators, 2 and 5, without a remainder.

$$\frac{1}{2} = \frac{5}{10}$$
$$\frac{2}{5} = \frac{4}{10}$$
$$\frac{9}{10}$$

Notice in this example that the common denominator, 10, is the product of 2 and 5.

If you cannot see the common denominator of two fractions quickly, you can always get a common denominator by multiplying the two denominators together.

Exercises

1. Ella bought $\frac{3}{4}$ doz. red roses and $\frac{2}{3}$ doz. white roses. How many dozen roses did she buy?

The common denominator is 12 because 12 contains both 4 and 3. You can get 12 by multiplying 4 by 3.

To change $\frac{3}{4}$ to *twelfths*, multiply both terms of $\frac{3}{4}$ by 3. How do you change $\frac{2}{3}$ to twelfths?

Ella bought $1\frac{5}{12}$ doz. roses.

Check the work by going over each step.

$$\frac{3}{4} = \frac{9}{12}$$
$$\frac{2}{3} = \frac{8}{12}$$
$$\frac{17}{12} = 1\frac{5}{12}$$

Add. Check the work by going over it again:

2.	$\frac{1}{3}$	**5.**	$\frac{1}{3}$	**8.**	$\frac{1}{6}$	**11.**	$\frac{1}{4}$	**14.**	$\frac{3}{4}$	**17.**	$\frac{1}{2}$
	$\frac{1}{2}$		$\frac{2}{5}$		$\frac{3}{5}$		$\frac{2}{5}$		$\frac{1}{5}$		$\frac{1}{9}$
3.	$\frac{2}{3}$	**6.**	$\frac{1}{3}$	**9.**	$\frac{2}{3}$	**12.**	$\frac{1}{6}$	**15.**	$\frac{2}{3}$	**18.**	$\frac{3}{8}$
	$\frac{1}{4}$		$\frac{3}{4}$		$\frac{1}{2}$		$\frac{1}{5}$		$\frac{2}{5}$		$\frac{1}{3}$
4.	$\frac{3}{5}$	**7.**	$\frac{3}{10}$	**10.**	$\frac{1}{3}$	**13.**	$\frac{2}{3}$	**16.**	$\frac{5}{8}$	**19.**	$\frac{4}{5}$
	$\frac{1}{2}$		$\frac{1}{3}$		$\frac{1}{4}$		$\frac{1}{8}$		$\frac{2}{3}$		$\frac{1}{3}$

USING FRACTIONS

1. Albert weighs 90 lb. Margaret weighs $82\frac{1}{4}$ lb. Margaret weighs how much less than Albert?

Subtract. Check the work by going over it again:

2. $8\frac{1}{8}$ − $6\frac{1}{3}$

3. $5\frac{2}{3}$ − $3\frac{3}{10}$

4. $8\frac{1}{5}$ − $2\frac{5}{6}$

5. $9\frac{1}{5}$ − $2\frac{3}{4}$

6. $5\frac{4}{5}$ − $3\frac{1}{2}$

7. $7\frac{2}{3}$ − $4\frac{4}{5}$

8. $8\frac{2}{3}$ − $6\frac{9}{10}$

9. $7\frac{3}{8}$ − $3\frac{1}{5}$

10. $8\frac{3}{5}$ − $6\frac{2}{3}$

11. $4\frac{5}{6}$ − $2\frac{4}{5}$

12. $9\frac{5}{8}$ − $7\frac{1}{3}$

13. $8\frac{4}{5}$ − $3\frac{3}{4}$

14. $6\frac{1}{2}$ − $\frac{3}{5}$

15. $9\frac{4}{5}$ − $5\frac{1}{3}$

16. $7\frac{3}{4}$ − $\frac{1}{3}$

HOW FAST CAN YOU WORK?

Can you add ex. 1 *to* 10 *in* 8 *minutes (after copying)?*

1. $7\frac{1}{2}$ + $3\frac{1}{4}$ + $4\frac{3}{8}$

2. $6\frac{1}{2}$ + $7\frac{1}{3}$ + $5\frac{1}{6}$

3. $6\frac{3}{4}$ + $4\frac{1}{2}$ + $5\frac{7}{8}$

4. $8\frac{1}{3}$ + $9\frac{1}{2}$ + $2\frac{5}{6}$

5. $4\frac{1}{5}$ + $7\frac{1}{10}$ + $5\frac{1}{2}$

6. $4\frac{5}{16}$ + $3\frac{3}{8}$ + $2\frac{1}{2}$

7. $4\frac{3}{4}$ + $3\frac{1}{4}$ + $7\frac{7}{8}$

8. $9\frac{9}{10}$ + $1\frac{1}{2}$ + $4\frac{2}{5}$

9. $6\frac{9}{16}$ + $3\frac{3}{4}$ + $5\frac{7}{8}$

10. $8\frac{1}{6}$ + $9\frac{2}{3}$ + $9\frac{1}{2}$

Can you subtract ex. 11 *to* 20 *in* 4 *minutes (after copying)?*

11. $8\frac{1}{2}$ − $5\frac{5}{8}$

12. $7\frac{2}{3}$ − $3\frac{1}{6}$

13. $9\frac{3}{4}$ − $4\frac{3}{8}$

14. $3\frac{2}{5}$ − $1\frac{7}{10}$

15. $7\frac{3}{4}$ − $4\frac{1}{3}$

16. $8\frac{5}{8}$ − $2\frac{5}{16}$

17. $7\frac{7}{10}$ − $5\frac{4}{5}$

18. $9\frac{1}{3}$ − $3\frac{5}{6}$

19. $8\frac{5}{8}$ − $2\frac{3}{4}$

20. $6\frac{1}{3}$ − $3\frac{1}{5}$

FINDING THE LEAST COMMON DENOMINATOR

The teacher asked Larry and Tom to add $\frac{1}{6}$ and $\frac{3}{4}$. This is the way each of them did it:

Larry's work

$$\frac{1}{6} = \frac{1\times4}{6\times4} = \frac{4}{24}$$
$$\frac{3}{4} = \frac{3\times6}{4\times6} = \frac{18}{24}$$
$$\frac{22}{24} = \frac{11}{12}$$

Tom's work

$$\frac{1}{6} = \frac{1\times2}{6\times2} = \frac{2}{12}$$
$$\frac{3}{4} = \frac{3\times3}{4\times3} = \frac{9}{12}$$
$$\frac{11}{12}$$

Larry got a common denominator of 24 by multiplying the denominators together. To change $\frac{1}{6}$ and $\frac{3}{4}$ to 24ths, he multiplied both terms of $\frac{1}{6}$ by 4 and both terms of $\frac{3}{4}$ by 6. He reduced $\frac{22}{24}$, the sum, to $\frac{11}{12}$.

Tom used a smaller common denominator, 12, which also contains both 6 and 4. He did the work as shown at the right above, and got the same answer as Larry. Tom did not have to reduce his answer to lowest terms as Larry did.

Both Larry and Tom worked the problem correctly; but it is better to use 12 as the common denominator, because small numbers are easier to work with. 12 is the **least common denominator** of 6 and 4 because it is the *smallest* number containing both 6 and 4. In this example the least common denominator is *smaller* than the product of the denominators.

Exercises

Add. Try to find the least common denominator:

1. $\frac{5}{6}$ $\frac{1}{4}$	3. $\frac{5}{6}$ $\frac{1}{10}$	5. $\frac{5}{8}$ $\frac{1}{10}$	7. $9\frac{7}{8}$ $2\frac{1}{20}$	9. $7\frac{1}{4}$ $4\frac{1}{6}$
2. $\frac{1}{8}$ $\frac{1}{6}$	4. $\frac{1}{9}$ $\frac{1}{6}$	6. $8\frac{3}{8}$ $3\frac{1}{6}$	8. $4\frac{3}{8}$ $5\frac{1}{6}$	10. $6\frac{1}{6}$ $3\frac{9}{10}$

A RULE FOR FINDING COMMON DENOMINATORS

In adding fractions such as $\frac{2}{3}$, $\frac{5}{6}$, and $\frac{3}{8}$, you must first find the *least* common denominator, which is the *smallest* number that will contain 3, 6, and 8 exactly. An easy way to do this is shown below.

$$\frac{2}{3} = \frac{16}{24}$$
$$\frac{5}{6} = \frac{20}{24}$$
$$\frac{3}{8} = \frac{9}{24}$$
$$\frac{45}{24} = 1\frac{21}{24} = 1\frac{7}{8}$$

First try the largest denominator, which is 8, and see if it contains both 6 and 3. You find that it *does not* contain both numbers. Then multiply 8 by 2, which gives 16, and see if 16 contains both 6 and 3. You still find that it *does not* contain them. Then multiply 8 by 3, which gives 24, and see if 24 contains both 6 and 3. You find that 24 *does* contain both 6 and 3, hence 24 is the least common denominator. Therefore change $\frac{2}{3}$, $\frac{5}{6}$, and $\frac{3}{8}$ each to 24ths, as shown above, and add the fractions. Then reduce $1\frac{21}{24}$ to $1\frac{7}{8}$.

To find the least common denominator, see if the largest denominator contains the other denominators. If not, multiply it in turn by 2, 3, 4, etc., until you get a number that exactly contains each denominator.

Exercises

Add. Find the least common denominator by the rule:

1. $5\frac{3}{10}$ $3\frac{1}{15}$	**2.** $4\frac{5}{6}$ $8\frac{3}{4}$	**3.** $9\frac{7}{8}$ $7\frac{5}{6}$	**4.** $6\frac{5}{6}$ $5\frac{7}{16}$	**5.** $5\frac{1}{12}$ $9\frac{5}{6}$
6. $8\frac{7}{10}$ $6\frac{5}{6}$	**7.** $2\frac{3}{10}$ $3\frac{7}{8}$	**8.** $7\frac{5}{8}$ $4\frac{5}{6}$	**9.** $9\frac{5}{8}$ $9\frac{7}{12}$	**10.** $5\frac{3}{4}$ $3\frac{5}{6}$
11. $7\frac{1}{2}$ $5\frac{2}{3}$ $3\frac{5}{6}$	**12.** $4\frac{2}{3}$ $6\frac{1}{2}$ $2\frac{1}{4}$	**13.** $8\frac{1}{2}$ $7\frac{5}{6}$ $9\frac{5}{12}$	**14.** $5\frac{1}{2}$ $4\frac{4}{5}$ $8\frac{7}{10}$	**15.** $3\frac{2}{3}$ $2\frac{3}{8}$ $6\frac{1}{2}$

EXERCISES IN FINDING COMMON DENOMINATORS

Add the following and check the work. Use the rule on page 71 for finding the least common denominator:

1. $1\frac{7}{8}$, $\frac{1}{2}$, $9\frac{5}{16}$

2. $1\frac{2}{3}$, $8\frac{11}{12}$, $9\frac{1}{2}$

3. $3\frac{3}{4}$, $8\frac{1}{6}$, $8\frac{1}{2}$

4. $9\frac{9}{10}$, $5\frac{2}{5}$, $4\frac{1}{4}$

5. $5\frac{2}{3}$, $\frac{3}{4}$, $6\frac{7}{12}$

6. $8\frac{1}{2}$, $5\frac{2}{3}$, $9\frac{4}{5}$

7. $7\frac{1}{3}$, $7\frac{5}{6}$, $3\frac{1}{9}$

8. $3\frac{1}{2}$, $2\frac{4}{5}$, $5\frac{4}{15}$

9. $7\frac{5}{6}$, $4\frac{1}{3}$, $9\frac{3}{8}$

10. $9\frac{1}{12}$, $5\frac{5}{8}$, $4\frac{1}{6}$

11. $7\frac{1}{2}$, $4\frac{2}{3}$, $6\frac{3}{4}$, $5\frac{11}{12}$

12. $9\frac{1}{2}$, $4\frac{2}{3}$, $3\frac{1}{4}$, $2\frac{5}{6}$

13. $7\frac{1}{3}$, $\frac{7}{8}$, $5\frac{1}{6}$, $4\frac{5}{12}$

14. $8\frac{2}{9}$, $6\frac{1}{3}$, $\frac{3}{4}$, $5\frac{5}{6}$

15. $1\frac{3}{8}$, $2\frac{1}{16}$, $9\frac{5}{12}$, $8\frac{1}{6}$

16. Fred weighed $96\frac{9}{10}$ lb. on one scale that registered tenths of a pound, and $96\frac{3}{4}$ lb. on another that registered fourths of a pound. On which scale did he weigh more? how much more?

17. In making furniture, thin layers of mahogany or other expensive woods are often glued over cheaper woods. These thin layers are called *veneering*. To a board $\frac{3}{8}$ in. thick, three layers of veneering are glued. Two of the layers are each $\frac{3}{32}$ in. thick and one layer is $\frac{1}{16}$ in. thick. What is the total thickness of the veneered board?

18. By using a stop watch, a foreman found that a lazy mechanic in his shop worked these lengths of time during one hour: $4\frac{2}{5}$ min., $6\frac{1}{2}$ min., $7\frac{3}{5}$ min., $4\frac{1}{10}$ min., $3\frac{3}{4}$ min., $4\frac{1}{3}$ min. How much time did the mechanic actually work?

IMPROVEMENT TEST No. 5

Test 5 A — Addition (Time 4 min.)

1. 41550 156 4198 818	**2.** 98856 6368 579 63795	**3.** 77668 46146 18978 4259	**4.** 47589 2455 53297 39
5. 99847 95 873 28297	**6.** 36036 4352 4820 36809	**7.** 65771 241 9512 94095	**8.** 14760 999 36893 366

Test 5 B — Subtraction (Time 4 min.)

1. \$586.06 147.54	**2.** \$675.20 285.70	**3.** \$760.87 286.79
4. \$768.21 591.32	**5.** \$942.56 568.47	**6.** \$820.00 284.19
7. \$952.41 284.06	**8.** \$861.27 601.50	**9.** \$526.64 165.75
10. \$629.07 213.59	**11.** \$755.90 195.81	**12.** \$940.01 172.90

Test 5 C — Multiplication (Time 4 min. after copying)

1. 605 346	**2.** 598 602	**3.** 932 158	**4.** 458 298	**5.** 706 907

Test 5 D — Division (Time 4 min. after copying)

1. $82\overline{)52070}$ **2.** $39\overline{)19827}$ **3.** $295\overline{)75637}$

MAGIC SQUARES WITH FRACTIONS

1. Here is a kind of magic square. Follow the directions carefully and you will discover something very interesting.

$\frac{7}{8}$	$\frac{3}{4}$	$\frac{3}{8}$
$\frac{1}{4}$	$\frac{5}{8}$	$\frac{9}{8}$
$\frac{7}{8}$	$\frac{5}{8}$	$\frac{1}{2}$

Add the three fractions in the top row. How much is $\frac{7}{8} + \frac{3}{4} + \frac{3}{8}$? Then add the three fractions in the middle row. Next add the bottom row. What is the sum each time?

Now add the three fractions in the left-hand column running up and down. How much is $\frac{7}{8} + \frac{1}{4} + \frac{7}{8}$? Add the middle column. Add the right-hand column. If your work is right, the six sums are all alike.

Test the following squares by adding each row and each column. Are the six sums alike in each square? Which square is not a magic square?

2.

$\frac{1}{3}$	$\frac{5}{6}$	$\frac{5}{6}$
$\frac{4}{3}$	$\frac{1}{4}$	$\frac{5}{12}$
$\frac{1}{3}$	$\frac{11}{12}$	$\frac{3}{4}$

3.

$\frac{1}{4}$	$\frac{1}{8}$	$\frac{5}{8}$
$\frac{5}{16}$	$\frac{5}{8}$	$\frac{1}{16}$
$\frac{7}{16}$	$\frac{1}{4}$	$\frac{5}{16}$

4.

$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$
$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$
$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$

5.

$\frac{2}{3}$	$\frac{10}{9}$	$\frac{2}{9}$
$\frac{2}{3}$	0	$\frac{4}{3}$
$\frac{2}{3}$	$\frac{8}{9}$	$\frac{4}{9}$

6. Complete this square so that the sum of each row and of each column is $1\frac{1}{2}$.

$\frac{1}{2}$	$\frac{1}{4}$	A
D	E	$\frac{1}{8}$
C	$\frac{3}{8}$	B

First put the right fraction in place of A so that the top row adds up to $1\frac{1}{2}$. After you find A, find the right fraction for B so that the right-hand column adds up to $1\frac{1}{2}$. Next find the right fraction for C so that the bottom row equals $1\frac{1}{2}$. Then find D so that the left-hand column equals $1\frac{1}{2}$. Finish by finding the right fraction for E to make the middle row equal $1\frac{1}{2}$. Now test your work by adding each row and each column to make sure that the six sums are all $1\frac{1}{2}$.

MAKING MAGIC SQUARES

Complete these squares by finding A, then B, C, D, and E. The sum for each row is above the square.

1. sum = 2

$\frac{1}{2}$	$\frac{3}{4}$	A
D	E	$\frac{5}{8}$
C	$\frac{9}{8}$	B

2. sum = $\frac{7}{8}$

$\frac{3}{16}$	$\frac{1}{4}$	A
D	E	$\frac{1}{16}$
C	$\frac{3}{8}$	B

3. sum = $\frac{7}{8}$

$\frac{1}{4}$	$\frac{3}{8}$	A
D	E	$\frac{1}{2}$
C	$\frac{1}{4}$	B

4. sum = $1\frac{1}{2}$

$\frac{3}{5}$	$\frac{7}{10}$	A
D	E	$\frac{2}{5}$
C	$\frac{1}{2}$	B

5. sum = 1

$\frac{1}{6}$	$\frac{1}{3}$	A
D	E	$\frac{1}{12}$
C	$\frac{1}{3}$	B

6. sum = 2

$\frac{7}{8}$	$\frac{5}{8}$	A
D	E	$\frac{9}{8}$
C	$\frac{7}{8}$	B

7. sum = $\frac{1}{2}$

$\frac{1}{16}$	$\frac{1}{4}$	A
D	E	$\frac{1}{8}$
C	0	B

8. sum = 1

$\frac{1}{16}$	$\frac{1}{2}$	A
D	E	$\frac{1}{4}$
C	$\frac{1}{16}$	B

PLAYING TIT-TAT-TO WITH FRACTIONS

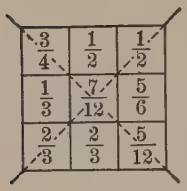
Helen and Tom play tit-tat-to on a magic square whose sum is 1 each time. Tom starts by putting $\frac{1}{5}$ in A. Helen puts $\frac{3}{10}$ in B. Then Helen and Tom each try to put a fraction in C that will make the top row add up to 1. As Helen gets $\frac{1}{2}$ first, she scores 1 point. Then Helen puts any small fraction, like $\frac{1}{10}$, in D. Tom finds $\frac{2}{5}$ for E first; he gets 1 point. Tom puts $\frac{1}{2}$ in F. If Helen fills G and H first and Tom fills J first, Helen wins because she has 3 points and Tom has only 2. Then they check the square to see if each sum is 1.

A $\frac{1}{5}$	B $\frac{3}{10}$	C $\frac{1}{2}$
H $\frac{7}{10}$	J $\frac{1}{5}$	D $\frac{1}{10}$
G $\frac{1}{10}$	F $\frac{1}{2}$	E $\frac{2}{5}$

Play this game. Make the sum any small number.

PERFECT MAGIC SQUARES

1. Add each row and each column in this magic square. Then add the three fractions along each of the dotted lines. If your work is right, you will get the same sum eight different times. This is a perfect magic square because it gives eight equal sums. It is much harder to make perfect magic squares than those on page 74.



Which of the following are perfect magic squares? Add each in eight different directions to find out:

2.

1/4	9/16	1/8
3/16	5/16	7/16
1/2	1/16	3/8

3.

1/3	3/2	2/3
7/6	5/6	1/2
1	1/6	4/3

4.

2/5	9/10	1/5
3/10	1/2	7/10
4/5	1/10	3/5

5. not

7/8	3/2	1/8
3/4	1/2	5/4
7/8	1/2	9/8

6.

2/3	3/2	1/3
1/2	5/6	7/6
4/3	1/6	6/6

7. not

1/2	9/10	2/5
6/5	3/10	3/10
1/10	3/5	11/10

8. not

1/2	0	5/8
1/2	3/8	1/4
1/2	3/4	1/4

9.

1/5	1/4	9/20
11/20	3/10	1/20
3/20	7/20	2/5

10.

1	1/8	3/4
3/8	5/8	7/8
1/2	9/8	1/4

11. not

7/8	1/8	3/4
3/8	1/2	7/8
1/2	9/8	1/8

12.

3/4	1/6	7/12
1/3	1/2	2/3
5/12	5/6	1/4

13.

5/12	1/8	1/3
5/24	7/24	3/8
1/4	11/24	1/6

DICK TELLS A SECRET ABOUT THE NUMBER 9

Dick asked Ella to find out if 9 would exactly divide 2651 or 1935. Ella did the work as shown here and said that 2651 is not divisible by 9 because there is a remainder of 5, but that 1935 is divisible by 9 because there is no remainder. To say that a number is *divisible* by 9 means that it is *exactly divisible* by 9, without a remainder.

$$9\overline{)2651} \qquad 294\tfrac{5}{9} \qquad\qquad 9\overline{)1935} \qquad 215$$

Dick then showed Ella a way of finding if a number is divisible by 9 *without actually dividing.* He added each of the figures, or *digits*, of 2651 thus: $2 + 6 + 5 + 1 = 14$. Since 14 is *not* divisible by 9, the number 2651 is *not* divisible by 9. Then he added the digits of 1935 thus: $1 + 9 + 3 + 5 = 18$. Since 18 *is* divisible by 9, then 1935 is divisible by 9.

A number is divisible by 9 *if the sum of its digits is divisible by* 9.

This rule is called a **test of divisibility** because it shows when a number is divisible by 9.

Exercises

Use Dick's rule to tell which of these numbers are divisible by 9. *Then divide each number by* 9 *to see if the rule always works:*

1. 137	**4.** 738	**7.** 8109	**10.** 5688	**13.** 81005
2. 243	**5.** 251	**8.** 2654	**11.** 8298	**14.** 60003
3. 528	**6.** 648	**9.** 3519	**12** 6660	**15.** 11223

16. Can Uncle Ben divide a collection of stamps equally among his 9 nephews, if it contains 1643 stamps? if it contains 2664 stamps? 1927 stamps? 1233 stamps?

DICK'S OTHER TESTS OF DIVISIBILITY

Dick also told Ella these simple rules:

A number is divisible by 3 *if the sum of its digits is divisible by* 3.

Thus, 114 is divisible by 3 because $1 + 1 + 4 = 6$, and 6 is divisible by 3; but 236 is not divisible by 3 because $2 + 3 + 6 = 11$, and 11 is not divisible by 3.

A number is divisible by 5 *if it ends in* 0 *or* 5.

Thus, 140 and 225 are divisible by 5, but 141 is not.

A number is divisible by 2 *if it ends in* 0, 2, 4, 6, *or* 8.

Thus, 458 is divisible by 2 because it ends in 8; but 359 is not divisible by 2 because it ends in 9.

A number like 8 or 42, which is exactly divisible by 2, is called an **even number.**

A number like 5 or 117, which is not divisible by 2, is called an **odd number.**

Exercises

1. Can you divide 75 boys into teams of 5 boys each so that there will be no boys left over? into teams of 3 boys each? of 9 boys each?

Which numbers are divisible by 2? *by* 3? *by* 5? *by* 9?

2. 745	**4.** 851	**6.** 276	**8.** 855	**10.** 1764
3. 879	**5.** 682	**7.** 105	**9.** 480	**11.** 4282

12. Are 765 and 1170 both divisible by 9? by 5? by 2?

13. Are 855 and 402 both divisible by 9? by 5? by 3?

Tell if both numbers are divisible by 2, 3, 5, *or* 9:

14. 78 and 42	**17.** 117 and 54	**20.** 270 and 315
15. 72 and 54	**18.** 165 and 75	**21.** 243 and 297
16. 70 and 130	**19.** 315 and 225	**22.** 450 and 270

REDUCING FRACTIONS BY CANCELLATION

You have learned that dividing both terms of a fraction by the *same* number does not change the value of the fraction. If you divide both terms of $\frac{12}{16}$ by 4, you get $\frac{3}{4}$, which has the same value as $\frac{12}{16}$.

$$\frac{12}{16} = \frac{12 \div 4}{16 \div 4} = \frac{3}{4}$$

Instead of writing the work as shown above, it is shorter to do it by **cancellation,** as shown here. When you divide both 12 and 16 by 4, you *cancel* 4. *Canceling* 4 means *dividing by* 4. Cross out 12 and 16 to show that they have been divided. You call 4 a **factor** of 12 because 4 divides 12 exactly. Is 4 also a factor of 16?

$$\frac{\overset{3}{\cancel{12}}}{\underset{4}{\cancel{16}}} = \frac{3}{4}$$

Exercises

1. Reduce $\frac{8}{16}$ to lowest terms.

In canceling the factor 8, remember that $8 \div 8 = 1$. When you cross out 8, it is safer to write the 1 above it. If you do not write the 1, you must think of it as there.

$$\frac{\overset{1}{\cancel{8}}}{\underset{2}{\cancel{16}}} = \frac{1}{2}$$

2. Reduce $\frac{15}{75}$ to lowest terms.

In this example you must cancel twice. First cancel 5 from both terms of $\frac{15}{75}$, which gives $\frac{3}{15}$. How do you know that 5 exactly divides both 15 and 75? Then cancel 3 from both terms of $\frac{3}{15}$, which gives $\frac{1}{5}$. Is $\frac{1}{5}$ the answer in the lowest terms? Tell why you cannot reduce $\frac{1}{5}$ further.

$$\frac{\overset{1}{\cancel{15}}}{\underset{5}{\cancel{75}}} = \frac{1}{5}$$

Reduce these to lowest terms, using cancellation:

3.	$\frac{9}{12}$	**6.**	$\frac{18}{20}$	**9.**	$\frac{18}{24}$	**12.**	$\frac{12}{30}$	**15.**	$\frac{16}{48}$	**18.**	$\frac{18}{96}$
4.	$\frac{12}{15}$	**7.**	$\frac{40}{55}$	**10.**	$\frac{15}{30}$	**13.**	$\frac{11}{33}$	**16.**	$\frac{28}{35}$	**19.**	$\frac{40}{160}$
5.	$\frac{24}{36}$	**8.**	$\frac{16}{32}$	**11.**	$\frac{20}{35}$	**14.**	$\frac{36}{64}$	**17.**	$\frac{25}{80}$	**20.**	$\frac{45}{120}$

REDUCING FRACTIONS IN LONG DIVISION

Maud is dividing 3960 by 225. Writing the remainder over the divisor to form a fraction, she gets a quotient of $17\frac{135}{225}$. She then reduces $\frac{135}{225}$ to lowest terms.

In reducing the fraction, Maud sees that both terms of $\frac{135}{225}$ are divisible by 5 because they both end in 5. Dividing both terms by 5, she gets $\frac{27}{45}$. How does she know that the terms of $\frac{27}{45}$ are not divisible by 2? that both terms are divisible by 9?

Maud's answer is $17\frac{3}{5}$. Why is $\frac{3}{5}$ an easier fraction to work with than $\frac{135}{225}$?

$$\begin{array}{r} 17\frac{135}{225} \\ 225\overline{)3960} \\ \underline{225} \\ 1710 \\ \underline{1575} \\ 135 \end{array} \qquad \begin{array}{c} 3 \\ \cancel{27} \\ \cancel{135} \\ \cancel{225} \\ \cancel{45} \\ 5 \end{array} = \frac{3}{5}$$

Exercises

1. There are 396 girls and 405 boys in the Grant School. Can the girls alone march by 3's and have no girls left over? Can the boys alone march by 3's?

Can the girls march by 5's? by 2's? by 9's? Can the boys march by 5's? by 2's? by 9's?

These fractions occur in long division. Reduce them to lowest terms, using the tests of divisibility:

2. $\frac{45}{75}$	**5.** $\frac{108}{234}$	**8.** $\frac{120}{225}$	**11.** $\frac{111}{303}$	**14.** $\frac{180}{315}$
3. $\frac{42}{84}$	**6.** $\frac{210}{360}$	**9.** $\frac{126}{225}$	**12.** $\frac{132}{174}$	**15.** $\frac{104}{312}$
4. $\frac{32}{96}$	**7.** $\frac{170}{250}$	**10.** $\frac{315}{405}$	**13.** $\frac{42}{114}$	**16.** $\frac{75}{105}$

Divide. Reduce fractions in quotients to lowest terms:

17. $1410 \div 24$	**20.** $5715 \div 135$	**23.** $3088 \div 216$
18. $6396 \div 48$	**21.** $8037 \div 360$	**24.** $7074 \div 486$
19. $7944 \div 72$	**22.** $4590 \div 864$	**25.** $4245 \div 240$

PROBLEMS GRANDFATHER USED TO WORK

When your grandfather was a boy, he had to work many long problems in fractions. Some of the problems in your grandfather's arithmetic book are given below. Though such problems are not used in business to-day, it will be fun to see whether you can work them and show that you are as clever at arithmetic as your grandfather was.

Exercises

Reduce these fractions to lowest terms:

1. $\frac{792}{864}$ 3. $\frac{288}{360}$ 5. $\frac{726}{792}$ 7. $\frac{252}{324}$ 9. $\frac{288}{504}$
2. $\frac{360}{468}$ 4. $\frac{258}{282}$ 6. $\frac{175}{375}$ 8. $\frac{468}{756}$ 10. $\frac{1176}{1680}$

Add the following. Use the rule on page 71 to find the least common denominator:

11. $\frac{1}{20} + \frac{1}{35}$
12. $\frac{1}{7} + \frac{2}{3} + \frac{3}{4}$
13. $\frac{4}{6} + \frac{7}{9} + \frac{5}{8}$
14. $\frac{4}{7} + \frac{3}{4} + \frac{11}{14}$
15. $2\frac{8}{11} + 6\frac{1}{5} + 12\frac{19}{22}$
16. $18\frac{5}{14} + 2\frac{4}{7} + 1\frac{11}{35}$
17. $900\frac{1}{10} + 450\frac{4}{5} + 75\frac{19}{25}$
18. $635\frac{15}{16} + 427\frac{12}{48} + 1625\frac{7}{8}$

In these problems, add or subtract as indicated:

19. $\frac{5}{7} - \frac{4}{9}$
20. $\frac{3}{8} - \frac{3}{11}$
21. $\frac{15}{16} - \frac{3}{6}$
22. $\frac{9}{14} - \frac{16}{63}$
23. $\frac{11}{12} - \frac{10}{11}$
24. $71\frac{1}{8} - 63\frac{7}{9}$
25. $18\frac{2}{3} + 16\frac{4}{5} - 21\frac{3}{10}$
26. $41\frac{1}{3} + 56 - 24\frac{7}{30} - 4\frac{11}{15}$

27. Henry had $148\frac{2}{3}$ A. of land. He bought $145\frac{2}{7}$ A. more and sold $238\frac{7}{12}$ A. How much remained?

28. A miller ground $7\frac{1}{3}$ bushels of corn for A, $9\frac{3}{4}$ bushels for B, $10\frac{1}{5}$ bushels for C. How much did he grind in all?

NOTE. The above examples were taken from textbooks in arithmetic published between 1860 and 1880.

MULTIPLYING A FRACTION BY A WHOLE NUMBER

1. How much is 5×1 apple? 5×1 third? $5 \times \frac{1}{3}$?

2. How much is 5×2 pears? 5×2 thirds? $5 \times \frac{2}{3}$?

3. If Laura practices on her violin $\frac{3}{4}$ hr. a day, how many hours does she spend at practicing in 6 days?

You must find what $6 \times \frac{3}{4}$ equals.

Just as 6×3 *dogs* $= 18$ *dogs*,
so 6×3 *fourths* $= 18$ *fourths*.
Hence $6 \times \frac{3}{4} = \frac{18}{4}$.
Change $\frac{18}{4}$ to $4\frac{2}{4}$, or $4\frac{1}{2}$.
Laura practices $4\frac{1}{2}$ hr. in 6 days.

$$6 \times \frac{3}{4} = \frac{6 \times 3}{4} = \frac{18}{4} = 4\frac{1}{2}$$

To multiply a fraction by a whole number, multiply the numerator by the whole number and divide the result by the denominator.

Oral Drill

Try to multiply mentally. Give results in lowest terms:

1. $3 \times \frac{1}{4}$	10. $9 \times \frac{1}{2}$	19. $9 \times \frac{2}{3}$	28. $5 \times \frac{1}{6}$
2. $2 \times \frac{1}{3}$	11. $8 \times \frac{1}{4}$	20. $2 \times \frac{1}{4}$	29. $4 \times \frac{1}{4}$
3. $4 \times \frac{1}{5}$	12. $6 \times \frac{2}{5}$	21. $3 \times \frac{1}{6}$	30. $9 \times \frac{1}{5}$
4. $5 \times \frac{2}{3}$	13. $4 \times \frac{3}{8}$	22. $6 \times \frac{3}{8}$	31. $2 \times \frac{3}{8}$
5. $3 \times \frac{1}{2}$	14. $5 \times \frac{7}{8}$	23. $3 \times \frac{4}{5}$	32. $4 \times \frac{2}{3}$
6. $6 \times \frac{1}{5}$	15. $8 \times \frac{1}{2}$	24. $2 \times \frac{1}{5}$	33. $6 \times \frac{3}{5}$
7. $5 \times \frac{1}{2}$	16. $6 \times \frac{2}{3}$	25. $4 \times \frac{3}{5}$	34. $4 \times \frac{5}{6}$
8. $4 \times \frac{1}{6}$	17. $9 \times \frac{1}{3}$	26. $2 \times \frac{7}{8}$	35. $7 \times \frac{1}{5}$
9. $8 \times \frac{3}{4}$	18. $2 \times \frac{5}{8}$	27. $6 \times \frac{1}{6}$	36. $8 \times \frac{2}{3}$

37. How many yards of cretonne does Joan need for 6 sofa cushions, if she needs $\frac{7}{8}$ yd. for each cushion?

RIDING TO SCHOOL

1. Every day Ralph rides $12\frac{3}{4}$ mi. going to and from school. How far does he ride in 23 school days?

First multiply $\frac{3}{4}$ by 23, which gives $17\frac{1}{4}$. Then multiply 12 by 23, placing the products as shown at the right. Add the products.

Check by going over the work.

Ralph rides $293\frac{1}{4}$ mi. in 23 school days.

$$\begin{array}{r} 12\frac{3}{4} \\ 23 \\ \hline 17\frac{1}{4} \\ 36 \\ 24 \\ \hline 293\frac{1}{4} \end{array}$$

$$23 \times \tfrac{3}{4} = \tfrac{69}{4} = 17\tfrac{1}{4}$$

2. Ann's daily ride to and from school covers $17\frac{1}{2}$ mi. How many miles does she ride in 22 days?

3. Billy travels $13\frac{3}{4}$ mi. a day in the school bus. How many miles does he ride in a term of 98 days?

Exercises

Multiply. Check your work by going over it:

1. $6\times3\frac{1}{2}$	**13.** $6\times14\frac{3}{8}$	**25.** $56\times14\frac{7}{8}$
2. $8\times5\frac{2}{3}$	**14.** $7\times14\frac{2}{5}$	**26.** $28\times13\frac{2}{3}$
3. $4\times3\frac{3}{4}$	**15.** $2\times17\frac{1}{2}$	**27.** $15\times28\frac{1}{2}$
4. $3\times3\frac{5}{8}$	**16.** $8\times11\frac{3}{4}$	**28.** $16\times19\frac{1}{8}$
5. $7\times6\frac{1}{2}$	**17.** $7\times15\frac{1}{2}$	**29.** $23\times18\frac{3}{8}$
6. $9\times6\frac{2}{3}$	**18.** $4\times16\frac{5}{6}$	**30.** $25\times13\frac{3}{5}$
7. $5\times9\frac{1}{4}$	**19.** $2\times25\frac{5}{6}$	**31.** $96\times11\frac{3}{4}$
8. $8\times7\frac{7}{8}$	**20.** $5\times18\frac{1}{4}$	**32.** $18\times13\frac{1}{2}$
9. $5\times8\frac{2}{3}$	**21.** $9\times13\frac{3}{5}$	**33.** $28\times11\frac{1}{4}$
10. $4\times9\frac{5}{8}$	**22.** $7\times10\frac{1}{2}$	**34.** $19\times12\frac{3}{8}$
11. $7\times2\frac{1}{4}$	**23.** $6\times27\frac{2}{3}$	**35.** $15\times19\frac{4}{5}$
12. $8\times5\frac{1}{2}$	**24.** $9\times19\frac{2}{3}$	**36.** $24\times16\frac{5}{12}$

MULTIPLYING A WHOLE NUMBER BY A FRACTION

1. How much will $\frac{3}{4}$ yd. of ribbon cost at 20¢ a yard?

You find that $\frac{3}{4}$ of 20¢ is 15¢, as in *A* below.

A. $\frac{1}{4}$ of 20 = 5
$\frac{3}{4}$ of 20 = 3×5, or 15

B. $\frac{1}{4}\times 20 = 5$
$\frac{3}{4}\times 20 = 3\times 5$, or 15

Another way to write $\frac{3}{4}$ of 20 is $\frac{3}{4} \times 20$, as shown in *B*. The sign × takes the place of the word " of " when written after a fraction.

Multiplying a number by a fraction is the same as taking a fractional part of it.

2. Find $\frac{1}{4}$ of 16. Find $\frac{3}{4}$ of 16. When you have found $\frac{1}{4}$ of a number, how do you find $\frac{3}{4}$ of the number?

3. Find $\frac{1}{4}$ of 24. Find $\frac{3}{4}$ of 24.

4. Find $\frac{1}{3}\times 36$; $\frac{2}{3}\times 36$; $\frac{1}{6}\times 36$; $\frac{5}{6}\times 36$.

5. If 1 lb. of tea costs 60¢, how much does $\frac{3}{4}$ lb. cost?

6. If Ruth sells candy at 48¢ a pound, how much does she charge for $\frac{5}{8}$ lb.? How much is $\frac{5}{8}\times 48$?

Multiply mentally:

7. $\frac{3}{8}\times 24$	**12.** $\frac{5}{6}\times 18$	**17.** $\frac{2}{3}\times 15$	**22.** $\frac{3}{4}\times 120$
8. $\frac{2}{3}\times 21$	**13.** $\frac{2}{7}\times 21$	**18.** $\frac{2}{9}\times 27$	**23.** $\frac{5}{9}\times 180$
9. $\frac{7}{8}\times 32$	**14.** $\frac{4}{5}\times 45$	**19.** $\frac{7}{8}\times 40$	**24.** $\frac{5}{6}\times 240$
10. $\frac{2}{5}\times 90$	**15.** $\frac{3}{5}\times 35$	**20.** $\frac{2}{3}\times 75$	**25.** $\frac{3}{5}\times 125$
11. $\frac{2}{5}\times 45$	**16.** $\frac{3}{8}\times 32$	**21.** $\frac{2}{3}\times 33$	**26.** $\frac{7}{8}\times 320$

In the above problems, the whole number is always exactly divisible by the denominator. In such problems you see that you multiply by using the following rule:

To multiply a whole number by a fraction, divide the whole number by the denominator, if it is exactly divisible; then multiply the result by the numerator.

MULTIPLYING A WHOLE NUMBER BY A FRACTION

A grocer charges 27¢ a pound for cookies. How much does he charge for $\frac{3}{4}$ lb.?

To find $\frac{3}{4} \times 27$ you may first divide 27 by 4 and then multiply by 3, as in *A*. But 4 does not divide 27 exactly; therefore it is better *first to multiply* 27 by 3 and *then to divide* the product by 4, as in *B*.

A. Here you divide first and then multiply.

$$4\overline{)27}$$
$$6\tfrac{3}{4}$$
$$3$$
$$2\tfrac{1}{4}$$
$$18$$
$$20\tfrac{1}{4}$$

B. Here you multiply first and then divide.

$$27 \times 3 = 81$$
$$4\overline{)81}$$
$$20\tfrac{1}{4}$$

B is shorter than *A* because there are fewer fractions to handle.

The cookies cost $20\frac{1}{4}$¢. Since a fraction of a cent is usually counted as an extra cent, the charge is 21¢.

When the denominator of the fraction does not divide the whole number exactly, use this rule:

To multiply a whole number by a fraction, multiply the whole number by the numerator and divide by the denominator.

This is like the rule on page 84. In both rules you always divide by the denominator. To help your memory, notice that *divide* and *denominator* both begin with *d*.

Exercises

Multiply, using the above rule:

1. $\frac{2}{3} \times 8$	6. $\frac{1}{3} \times 10$	11. $\frac{2}{3} \times 10$	16. $\frac{3}{8} \times 30$
2. $\frac{3}{4} \times 6$	7. $\frac{4}{5} \times 12$	12. $\frac{5}{8} \times 45$	17. $\frac{3}{4} \times 25$
3. $\frac{5}{6} \times 8$	8. $\frac{5}{8} \times 36$	13. $\frac{3}{4} \times 75$	18. $\frac{7}{8} \times 124$
4. $\frac{3}{8} \times 9$	9. $\frac{4}{5} \times 14$	14. $\frac{7}{8} \times 50$	19. $\frac{4}{5} \times 164$
5. $\frac{2}{3} \times 5$	10. $\frac{3}{8} \times 36$	15. $\frac{5}{8} \times 25$	20. $\frac{3}{4} \times 125$

ADVERTISING IN A SCHOOL PAPER

Count a fraction of a cent as an extra cent.

1. The Ralston School paper charges \$25 a page for advertising. Complete the table at the right, giving the price for each part of a page.

2. If a school paper charges $12\frac{1}{2}¢$ a line, how much does a 9-line advertisement cost?

3. At \$15.50 a page, how much do you pay for an advertisement covering $\frac{3}{4}$ of a page?

RALSTON NEWS

ADVERTISING RATES

1 page	\$25.00
$\frac{3}{4}$ page	
$\frac{5}{8}$ page	
$\frac{1}{2}$ page	
$\frac{3}{8}$ page	
$\frac{1}{4}$ page	
$\frac{1}{8}$ page	

4. How much do you pay for an 8-line advertisement in a school paper at $6\frac{1}{2}¢$ a line? at $6\frac{3}{4}¢$ a line?

Other Problems

1. Lucy needs $\frac{7}{8}$ yd. of linen for each of 6 towels which she is making. How much linen does she need?

2. Joseph spends $4\frac{3}{4}$ hr. a day in school. How many hours does he spend in school in 5 days?

Multiply mentally when possible. In each example tell whether you use the rule on page 84 *or that on page* 85:

3. $\frac{2}{3}\times 15$	**11.** $\frac{3}{4}\times 85$	**19.** $\frac{3}{8}\times 84$	**27.** $\frac{5}{6}\times 126$
4. $\frac{7}{8}\times 10$	**12.** $\frac{3}{8}\times 64$	**20.** $\frac{4}{5}\times 98$	**28.** $\frac{3}{4}\times 175$
5. $\frac{2}{5}\times 20$	**13.** $\frac{3}{8}\times 25$	**21.** $\frac{3}{4}\times 60$	**29.** $\frac{2}{3}\times 150$
6. $\frac{5}{8}\times 56$	**14.** $\frac{5}{8}\times 75$	**22.** $\frac{3}{8}\times 96$	**30.** $\frac{3}{4}\times 110$
7. $\frac{1}{4}\times 75$	**15.** $\frac{5}{9}\times 50$	**23.** $\frac{2}{3}\times 60$	**31.** $\frac{3}{4}\times 200$
8. $\frac{4}{5}\times 50$	**16.** $\frac{5}{6}\times 30$	**24.** $\frac{7}{8}\times 45$	**32.** $\frac{2}{5}\times 550$
9. $\frac{3}{4}\times 80$	**17.** $\frac{3}{4}\times 35$	**25.** $\frac{9}{10}\times 90$	**33.** $\frac{2}{3}\times 240$
10. $\frac{2}{3}\times 24$	**18.** $\frac{7}{8}\times 40$	**26.** $\frac{3}{10}\times 50$	**34.** $\frac{3}{16}\times 160$

MULTIPLYING BY A MIXED NUMBER

John earned \$.25 an hour delivering groceries. Last week he worked $16\frac{3}{4}$ hr. How much did he earn?

You must multiply \$.25 by $16\frac{3}{4}$.

First find what John earned for working $\frac{3}{4}$ hr. by multiplying \$.25 by $\frac{3}{4}$. Next find what he earned for 16 hr. by multiplying \$.25 by 16. Then add the products. In the result, call $\frac{3}{4}$¢ another cent. John earned \$4.19.

$$\begin{array}{r} \$.25 \\ 16\frac{3}{4} \\ \hline 18\frac{3}{4} \\ 150 \\ 25 \\ \hline \$4.18\frac{3}{4} \end{array}$$

To multiply a whole number by a mixed number, multiply first by the fraction and then by the whole number and add the products.

Exercises

Multiply. Check the work by going over it again:

1. $4\frac{1}{2}\times56$
2. $3\frac{5}{6}\times20$
3. $4\frac{3}{4}\times60$
4. $5\frac{2}{5}\times26$
5. $5\frac{3}{8}\times40$
6. $4\frac{2}{7}\times35$
7. $2\frac{7}{8}\times15$
8. $3\frac{1}{4}\times48$
9. $7\frac{1}{2}\times36$
10. $4\frac{1}{3}\times25$
11. $6\frac{3}{4}\times30$
12. $9\frac{3}{8}\times25$
13. $4\frac{1}{3}\times47$
14. $5\frac{2}{5}\times16$
15. $4\frac{2}{7}\times28$
16. $6\frac{4}{5}\times40$
17. $3\frac{5}{8}\times24$
18. $4\frac{2}{3}\times25$
19. $6\frac{2}{3}\times39$
20. $5\frac{3}{4}\times64$
21. $2\frac{5}{8}\times45$
22. $7\frac{2}{5}\times50$
23. $2\frac{1}{2}\times15$
24. $4\frac{1}{4}\times21$
25. $5\frac{2}{5}\times36$
26. $4\frac{3}{8}\times48$
27. $7\frac{2}{3}\times33$
28. $5\frac{5}{16}\times25$
29. $7\frac{7}{16}\times32$
30. $4\frac{5}{12}\times36$
31. $8\frac{4}{5}\times\$1.35$
32. $9\frac{2}{3}\times\$2.50$
33. $7\frac{3}{4}\times\$1.85$
34. $3\frac{3}{4}\times\$4.70$
35. $1\frac{5}{8}\times\$1.44$
36. $4\frac{3}{8}\times\$4.00$
37. $3\frac{1}{4}\times\$2.55$
38. $4\frac{1}{2}\times\$2.94$
39. $5\frac{3}{4}\times\$5.00$
40. $6\frac{1}{2}\times\$5.00$
41. $2\frac{1}{2}\times\$6.65$
42. $2\frac{3}{16}\times\$3.20$
43. $6\frac{1}{12}\times\$1.20$
44. $2\frac{2}{5}\times\$10.00$
45. $3\frac{1}{4}\times\$12.00$

MRS. KING GOES SHOPPING

1. Last Saturday Mrs. King went shopping. She bought $2\frac{3}{4}$ yd. of muslin at 20¢ a yard and $2\frac{3}{8}$ yd. of gingham at 39¢ a yard. How much did both cost?

2. Mrs. King also bought $3\frac{1}{2}$ yd. of white satin at \$1.45 a yard and $2\frac{3}{4}$ yd. of silk crêpe at \$1.88 a yard. How much did she spend at the silk counter?

3. How much did she have to pay for $7\frac{3}{4}$ yd. of cretonne at 48¢ a yard?

4. Mrs. King bought $3\frac{3}{8}$ yd. of imported lace at 64¢ a yard and $2\frac{1}{4}$ yd. of lace edging at 15¢ a yard. How much did she pay for lace?

5. At the baker's she ordered $\frac{3}{4}$ doz. rolls at 20¢ a dozen and $1\frac{1}{4}$ doz. buns at 30¢ a dozen. How much did this order cost?

6. Mrs. King placed this order with the Hilltop Dairy: $\frac{1}{2}$ lb. sweet butter at 46¢ a pound, $1\frac{1}{4}$ lb. dates at 24¢ a pound, $1\frac{3}{4}$ lb. apricots at 28¢ a pound, $2\frac{1}{2}$ doz. Leghorn eggs at 56¢ a dozen, $\frac{5}{8}$ lb. American cheese at 35¢ a pound. How much was her bill for this order?

7. At the grocer's she ordered $2\frac{1}{2}$ lb. string beans at 15¢ a pound, $\frac{1}{2}$ doz. bananas at 50¢ a dozen, $3\frac{1}{2}$ lb. apples at 8¢ a pound, a $1\frac{7}{8}$-pound cabbage at 8¢ a pound, $2\frac{3}{4}$ doz. lemons at 36¢ a dozen, and $\frac{3}{4}$ lb. tea at 96¢ a pound. How much did that order cost?

8. How much must Mrs. King pay at the fish store for some codfish weighing $2\frac{5}{8}$ lb. and costing 19¢ a pound?

9. For Jane's birthday she bought at the florist's $3\frac{1}{2}$ doz. carnations at \$1.85 a dozen and $1\frac{1}{4}$ doz. chrysanthemums at \$3.25 a dozen. How much did they cost in all?

WATCHING THE NUMBER 1

The number 1 is a very interesting number, but unless you watch it, it will play tricks on you. In watching 1's, remember that a fraction may indicate division.

Thus, $\frac{5}{5}$ means $5 \div 5$, or 1. $\frac{5}{1}$ means $5 \div 1$, or 5.

1. Write the multiplication table of 1's like this: $1 \times 1 = 1$, $2 \times 1 = 2$, etc., up to 12×1. Then write it like this: $1 \times 1 = 1$, $1 \times 2 = 2$, $1 \times 3 = 3$, etc.

2. Write a table like this: $\frac{1}{1} = 1$, $\frac{2}{2} = 1$, etc.

3. Write a table like this: $\frac{1}{1} = 1$, $\frac{2}{1} = 2$, etc.

Tell what each of the following equals:

4. $\frac{1}{1}$

5. $\frac{2}{2}$

6. $\frac{30}{1}$

7. $\frac{1 \times 4}{1 \times 1}$

8. $1 \div 1$

9. 1×1

10. $\frac{1}{4}$ of 4

11. $\frac{1 \times 1}{1 \times 1}$

12. $1\overline{)1}$

13. $\frac{1}{3}$ of 3

14. $\frac{4}{4} + \frac{4}{1}$

15. $\frac{3 \times 1}{1}$

16. $\frac{5}{5} + \frac{5}{5}$

17. $\frac{5}{1} + \frac{5}{1}$

18. $1 \times 1 \times 1$

19. $\frac{1}{4 \times 1}$

20. What does $263 \div 263$ equal? What does $145\overline{)145}$ equal? What does any number divided by itself equal?

21. Warren asks the pupils in his class to write something equal to 2 by using four 1's.

Anna does it like this: $\frac{1}{1} + \frac{1}{1}$. Is she right?

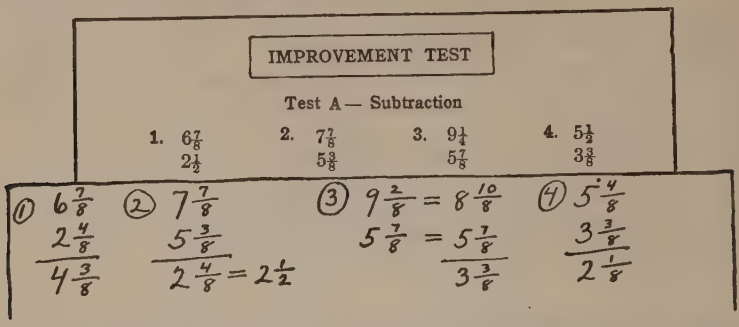
Joe does it like this: $1+1+1-1$. Is he right?

Mary does it like this: $\frac{1 \times 1}{1} + 1$. Is she right?

22. Write something equal to 8 by using three 7's and one 1. Write something equal to 4 by using nine 1's.

23. Make up other tricks in which you use 1's.

TAKING AN IMPROVEMENT TEST IN FRACTIONS



In taking an Improvement Test in the addition or subtraction of fractions, like Test 6 A or 6 B, first place the edge of your paper just under the top row of examples. Write ex. 1 on your paper under ex. 1 of the test; but, instead of copying the example exactly as it stands in the test, change the fractions, as you copy, to fractions having a common denominator. When you have worked the first example, slide your paper slightly to the left and copy ex. 2 in the same way. Write the number of each example in a circle, as shown in the illustration above.

When you have done all the examples in the first row of the test, fold under the examples on your paper and do the next row along the folded edge of the paper. After finishing the second row, fold your work under again, and so on.

The illustration at the top of this page shows how the first row of examples in a subtraction test similar to Test 6 B should look on your paper. Study it carefully and tell how each example was changed as it was copied.

NOTE. The time allowed for tests in the addition or subtraction of fractions includes the copying of each example in the new form, in which the fractions have a common denominator.

IMPROVEMENT TEST NO. 6

Test 6 A — Addition (Time 4 min.)

1. $4\frac{1}{8}$ + $1\frac{3}{8}$	**2.** $2\frac{3}{4}$ + $8\frac{3}{4}$	**3.** $5\frac{1}{8}$ + $8\frac{1}{4}$	**4.** $4\frac{5}{8}$ + $1\frac{3}{4}$
5. $5\frac{2}{5}$ + $4\frac{4}{5}$	**6.** $5\frac{1}{3}$ + $1\frac{1}{3}$	**7.** $6\frac{3}{4}$ + $3\frac{1}{2}$	**8.** $9\frac{11}{16}$ + $2\frac{1}{4}$
9. $5\frac{7}{8}$ + $2\frac{1}{2}$	**10.** $7\frac{2}{5}$ + $7\frac{1}{2}$	**11.** $6\frac{1}{2}$ + $4\frac{3}{10}$	**12.** $9\frac{3}{4}$ + $8\frac{1}{12}$

Test 6 B — Subtraction (Time 4 min.)

1. $7\frac{5}{8}$ − $6\frac{3}{8}$	**2.** $5\frac{5}{12}$ − $1\frac{5}{12}$	**3.** $6\frac{1}{2}$ − $5\frac{5}{8}$	**4.** $6\frac{3}{4}$ − $4\frac{5}{8}$
5. $4\frac{7}{8}$ − $3\frac{1}{2}$	**6.** $9\frac{1}{4}$ − $3\frac{3}{4}$	**7.** $6\frac{7}{10}$ − $6\frac{1}{2}$	**8.** $7\frac{1}{8}$ − $4\frac{7}{8}$
9. 8 − $2\frac{3}{8}$	**10.** $6\frac{9}{10}$ − $2\frac{1}{2}$	**11.** $7\frac{2}{3}$ − $4\frac{1}{6}$	**12.** $9\frac{5}{6}$ − $3\frac{1}{4}$

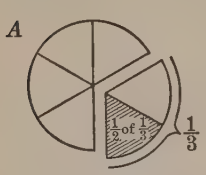
Test 6 C — Addition (Time 4 min.)

1. $4\frac{1}{2}$ + $6\frac{3}{4}$ + $8\frac{5}{16}$	**2.** $8\frac{1}{4}$ + $7\frac{5}{6}$ + $2\frac{11}{12}$	**3.** $6\frac{1}{2}$ + $4\frac{3}{5}$ + $1\frac{7}{10}$	**4.** $3\frac{3}{4}$ + $4\frac{1}{2}$ + $5\frac{3}{8}$	**5.** $3\frac{1}{2}$ + $2\frac{2}{3}$ + $7\frac{3}{4}$

MULTIPLYING A FRACTION BY A FRACTION

1. Bob cuts $\frac{1}{2}$ of a melon into 2 equal pieces. Then each piece is $\frac{1}{4}$ of a whole melon. What is $\frac{1}{2}$ of $\frac{1}{2}$?

Another way to write $\frac{1}{2}$ of $\frac{1}{2}$ is $\frac{1}{2}\times\frac{1}{2}$, since the sign $\times$ after a fraction takes the place of the word "of." How much is $\frac{1}{2}\times\frac{1}{2}$?



2. John buys $\frac{1}{3}$ of a pie and eats $\frac{1}{2}$ of it. Look at *A* above and tell what part of the whole pie he eats. What is $\frac{1}{2}$ of $\frac{1}{3}$? $\frac{1}{2}\times\frac{1}{3}$?

3. Ida has $\frac{1}{4}$ of a pie and gives $\frac{1}{2}$ of it to Ann. Look at *B* above and tell what part of a whole pie Ann gets. What is $\frac{1}{2}$ of $\frac{1}{4}$? $\frac{1}{2}\times\frac{1}{4}$?

4. Look at *C* above. $\frac{3}{4}$ of $\frac{1}{2}$ of a pie equals how many eighths of a whole pie? Hence $\frac{3}{4}\times\frac{1}{2}$ equals what?

5. Instead of finding the products by making drawings, you can get the results quickly like this:

$$\frac{1}{2}\times\frac{1}{3}=\frac{1\times1}{2\times3}=\frac{1}{6} \qquad \frac{3}{4}\times\frac{1}{2}=\frac{3\times1}{4\times2}=\frac{3}{8}$$

In each problem, you first multiplied the numerators together and then multiplied the denominators together.

To multiply a fraction by a fraction, multiply the numerators together for a new numerator and the denominators together for a new denominator.

PROBLEMS

1. A cream pitcher holds $\frac{3}{4}$ pt. of cream. When it is half full, what part of a pint does it hold?

2. Will picks $\frac{3}{4}$ bu. of berries for Mr. Cox. If he receives $\frac{1}{3}$ of all he picks, what part of a bushel of berries does he get? What is $\frac{1}{3}\times\frac{3}{4}$?

3. A recipe calls for $\frac{2}{3}$ cup of sugar. Nell makes $\frac{3}{4}$ the amount of the recipe. How much sugar does she need? What does $\frac{3}{4}\times\frac{2}{3}$ equal?

4. It takes James $\frac{2}{3}$ hr. to walk to school. His father says it would take him only $\frac{1}{4}$ as long to ride. How long would it take him to ride? What is $\frac{1}{4}\times\frac{2}{3}$?

5. Frank has $\frac{5}{8}$ lb. of candy. He gives Ted $\frac{1}{2}$ of it. What part of a pound does he give Ted?

6. Mary buys $\frac{3}{4}$ yd. of blue ribbon and divides it into 6 equal parts for badges. How long will each badge be? What does $\frac{1}{6}$ of $\frac{3}{4}$ equal? What is $\frac{1}{6}\times\frac{3}{4}$?

Multiply. Reduce the results when possible:

7. $\frac{1}{2}\times\frac{1}{4}$	**17.** $\frac{7}{8}$ of $\frac{1}{2}$	**27.** $\frac{2}{3}\times\frac{1}{2}$	**37.** $\frac{3}{5}\times\frac{1}{3}$
8. $\frac{1}{2}\times\frac{1}{2}$	**18.** $\frac{2}{3}$ of $\frac{1}{4}$	**28.** $\frac{3}{5}\times\frac{1}{2}$	**38.** $\frac{3}{4}\times\frac{1}{4}$
9. $\frac{1}{2}\times\frac{1}{3}$	**19.** $\frac{1}{3}$ of $\frac{3}{4}$	**29.** $\frac{3}{5}\times\frac{3}{4}$	**39.** $\frac{5}{8}\times\frac{3}{5}$
10. $\frac{3}{4}\times\frac{1}{2}$	**20.** $\frac{2}{3}$ of $\frac{1}{5}$	**30.** $\frac{2}{3}\times\frac{4}{5}$	**40.** $\frac{1}{3}\times\frac{1}{3}$
11. $\frac{1}{4}\times\frac{1}{2}$	**21.** $\frac{1}{2}$ of $\frac{1}{5}$	**31.** $\frac{5}{8}\times\frac{1}{2}$	**41.** $\frac{3}{4}\times\frac{2}{5}$
12. $\frac{1}{2}\times\frac{3}{8}$	**22.** $\frac{1}{3}$ of $\frac{1}{8}$	**32.** $\frac{2}{5}\times\frac{1}{3}$	**42.** $\frac{1}{5}\times\frac{2}{5}$
13. $\frac{1}{2}\times\frac{3}{5}$	**23.** $\frac{3}{8}$ of $\frac{1}{2}$	**33.** $\frac{1}{2}\times\frac{2}{3}$	**43.** $\frac{4}{5}\times\frac{5}{8}$
14. $\frac{1}{4}\times\frac{1}{3}$	**24.** $\frac{1}{2}$ of $\frac{2}{5}$	**34.** $\frac{2}{3}\times\frac{3}{4}$	**44.** $\frac{3}{4}\times\frac{4}{5}$
15. $\frac{1}{4}\times\frac{4}{5}$	**25.** $\frac{1}{4}$ of $\frac{3}{4}$	**35.** $\frac{2}{3}\times\frac{5}{8}$	**45.** $\frac{7}{8}\times\frac{2}{3}$
16. $\frac{2}{3}\times\frac{2}{5}$	**26.** $\frac{1}{5}$ of $\frac{1}{3}$	**36.** $\frac{1}{4}\times\frac{1}{4}$	**46.** $\frac{2}{3}\times\frac{3}{5}$

HOW TO CANCEL IN MULTIPLYING FRACTIONS

1. Harry rode $\frac{4}{5}$ mi. on his bicycle in 6 min. What part of a mile did he ride in 1 min.?

You can find $\frac{1}{6}$ of $\frac{4}{5}$ either as shown in *A* or as in *B*.

In *A* you first multiply the numerators together and the denominators together and get $\frac{4}{30}$; then you reduce $\frac{4}{30}$ to $\frac{2}{15}$ by dividing both terms by 2. Here you reduce the result to lowest terms *after multiplying*.

A. $\frac{1}{6}\times\frac{4}{5}=\frac{1\times4}{6\times5}=\frac{4}{30}=\frac{2}{15}$

Think the step in the dotted square. Do not write it.

In *B* you first divide both 4 and 6 by 2, thus *canceling* 2 from 4 and 6. Then you multiply as shown in the dotted square. You get $\frac{2}{15}$ as a result, which is already in lowest terms because you did the reducing *before multiplying* by canceling 2 from 4 and 6.

B. $\frac{1}{\cancel{6}_{3}}\times\frac{\overset{2}{\cancel{4}}}{5}=\frac{1\times2}{3\times5}=\frac{2}{15}$

You see that it is shorter to do the work as shown in *B*.

2. Multiply $\frac{5}{6}$ by $\frac{2}{3}$.

In canceling the factor 2 from 2 and 6, think "2 ÷ 2 = 1," and write 1 over 2; then think "6 ÷ 2 = 3," and write 3 under 6.

$\frac{5}{\cancel{6}_{3}}\times\frac{\overset{1}{\cancel{2}}}{3}=\frac{5\times1}{3\times3}=\frac{5}{9}$

Explain each step in the following problems. In ex. 4 notice that you cancel twice.

3. Find $\frac{7}{16}$ of 24.

$\frac{7}{16}\times24=\frac{7\times\overset{3}{\cancel{24}}}{\underset{2}{\cancel{16}}}=\frac{21}{2}=10\frac{1}{2}$

4. Find $\frac{5}{6}\times\frac{9}{10}$.

$\frac{\overset{1}{5}}{\underset{2}{6}}\times\frac{\overset{3}{9}}{\underset{2}{10}}=\frac{3}{4}$

When you cancel in multiplying fractions, you divide a numerator and a denominator by the same number.

GRADED EXERCISES

Multiply the following. Cancel when you can:

Group			
A.	1. $\frac{3}{8}\times\frac{4}{5}$	2. $\frac{5}{6}\times\frac{2}{3}$	3. $\frac{7}{8}\times\frac{2}{3}$
	4. $\frac{2}{5}\times\frac{3}{4}$	5. $\frac{2}{3}\times\frac{5}{8}$	6. $\frac{3}{4}\times\frac{5}{6}$
B.	7. $\frac{2}{3}\times\frac{6}{7}$	8. $\frac{3}{5}\times\frac{15}{16}$	9. $\frac{2}{7}\times\frac{14}{15}$
	10. $\frac{4}{5}\times\frac{10}{3}$	11. $\frac{5}{2}\times\frac{8}{9}$	12. $\frac{7}{8}\times\frac{16}{3}$
C.	13. $\frac{1}{3}\times\frac{9}{10}$	14. $\frac{1}{5}\times\frac{10}{11}$	15. $\frac{1}{2}\times\frac{4}{5}$
	16. $\frac{1}{4}\times\frac{8}{9}$	17. $\frac{1}{3}\times\frac{6}{7}$	18. $\frac{1}{2}\times\frac{8}{9}$
	19. $\frac{3}{5}\times\frac{5}{8}$	20. $\frac{5}{7}\times\frac{7}{12}$	21. $\frac{3}{4}\times\frac{4}{5}$
D.	22. $\frac{3}{4}\times\frac{6}{7}$	23. $\frac{1}{4}\times\frac{3}{5}$	24. $\frac{3}{4}\times\frac{6}{5}$
	25. $\frac{1}{6}\times\frac{4}{5}$	26. $\frac{1}{6}\times\frac{9}{16}$	27. $9\times\frac{5}{6}$
	28. $\frac{1}{4}\times\frac{10}{3}$	29. $\frac{5}{6}\times\frac{9}{2}$	30. $\frac{5}{8}\times\frac{10}{3}$
	31. $10\times\frac{3}{8}$	32. $18\times\frac{5}{12}$	33. $\frac{1}{6}\times\frac{9}{10}$
	34. $15\times\frac{8}{9}$	35. $15\times\frac{3}{10}$	36. $24\times\frac{3}{16}$
E.	37. $24\times\frac{7}{8}$	38. $24\times\frac{1}{4}$	39. $27\times\frac{2}{3}$
	40. $\frac{3}{4}\times16$	41. $\frac{5}{6}\times18$	42. $\frac{2}{3}\times21$
F.	43. $\frac{3}{4}\times\frac{8}{15}$	44. $\frac{2}{3}\times\frac{15}{16}$	45. $\frac{2}{3}\times\frac{9}{8}$
	46. $\frac{2}{3}\times\frac{9}{10}$	47. $\frac{4}{5}\times\frac{15}{8}$	48. $\frac{5}{3}\times\frac{9}{10}$
G.	49. $\frac{5}{6}\times\frac{9}{10}$	50. $\frac{3}{4}\times\frac{10}{3}$	51. $\frac{8}{9}\times\frac{15}{4}$
	52. $\frac{7}{8}\times\frac{10}{7}$	53. $\frac{5}{6}\times\frac{4}{5}$	54. $\frac{15}{16}\times\frac{12}{25}$

NOTE. The above examples are graded according to types of difficulty.

THE NUMBER 1 PLAYS HIDE AND GO SEEK

The number 1 often causes trouble in cancellation because it seems to hide behind other numbers.

1. Find $\frac{1}{4}$ of $\frac{4}{5}$.

When you cancel the 4 in the numerator, think "$4 \div 4 = 1$" and write 1 *over* the 4. In the denominator also think "$4 \div 4 = 1$" and write 1 *under* the 4. How much is 1×1? How much is 1×5?

$$\frac{1}{\cancel{4}} \times \frac{\overset{1}{\cancel{4}}}{5} = \frac{1 \times 1}{1 \times 5} = \frac{1}{5}$$

2. Multiply $\frac{3}{4}$ by $\frac{2}{9}$.

In this example you must cancel twice. What do you think when you cancel 3 from 3 and 9? What do you think when you cancel 2 from 2 and 4? In the answer, $\frac{1}{6}$, how did you get the 1? How did you get the 6?

$$\frac{\overset{1}{\cancel{2}}}{\cancel{3}} \times \frac{\overset{1}{\cancel{3}}}{\cancel{4}} = \frac{1}{6}$$
$$\cancel{9} \quad \cancel{4}$$
$$3 \quad 2$$

3. Multiply $\frac{3}{2}$ by $\frac{2}{3}$.

Eva worked the problem as in *A*. She said that the answer is 1.

$$A. \quad \frac{\overset{1}{\cancel{2}}}{\cancel{3}} \times \frac{\overset{1}{\cancel{3}}}{\cancel{2}} = \frac{1 \times 1}{1 \times 1} = 1$$
$$1 \quad 1$$

Bert did the work as in *B*, without writing the 1's when he canceled. He said that the answer is nothing, or 0, because everything is canceled. Why was he wrong?

$$B. \quad \frac{\cancel{2}}{\cancel{3}} \times \frac{\cancel{3}}{\cancel{2}} = 0$$

4. In working the problems below, Jack remembered the 1's instead of writing them. Find the answers:

$$(a) \quad 6 \times \frac{5}{6} = \frac{\cancel{6} \times 5}{\cancel{6}} = ? \qquad (b) \quad \frac{1}{\cancel{5}} \times \frac{\cancel{5}}{6} = ? \qquad (c) \quad \frac{\cancel{8}}{\cancel{5}} \times \frac{\overset{3}{\cancel{15}}}{\cancel{8}} = ?$$

After you thoroughly understand cancellation, you may remember the 1's instead of putting them down. In working harder problems, however, you will avoid many mistakes if you write the 1's.

WATCHING THE NUMBER 1 IN CANCELLATION

Tell how each problem is done and give the result:

1. $\frac{1}{\cancel{7}}\times\frac{\cancel{7}}{8} = ?$

2. $\frac{\cancel{4}\times 3}{\cancel{4}} = ?$

3. $\frac{1}{\cancel{3}}\times\frac{\overset{3}{\cancel{9}}}{10} = ?$

4. $\frac{\cancel{5}}{\cancel{6}}\times\frac{\overset{2}{\cancel{12}}}{\cancel{5}} = ?$

5. $\frac{\cancel{4}}{\cancel{5}}\times\frac{\cancel{5}}{\cancel{4}} = ?$

6. $\frac{\cancel{5}}{\underset{2}{\cancel{6}}}\times\frac{\cancel{3}}{\underset{2}{\cancel{10}}} = ?$

Exercises in Multiplying Fractions

Multiply, canceling when you can:

Group			
C.	1. $\frac{1}{2}\times\frac{6}{7}$	2. $\frac{1}{4}\times\frac{8}{5}$	3. $\frac{1}{5}\times\frac{10}{3}$
E.	4. $28\times\frac{3}{4}$	5. $16\times\frac{7}{8}$	6. $\frac{1}{2}\times 18$
F.	7. $\frac{2}{3}\times\frac{9}{16}$	8. $\frac{8}{9}\times\frac{3}{4}$	9. $\frac{4}{5}\times\frac{15}{16}$
H.	10. $\frac{1}{4}\times\frac{4}{9}$	11. $\frac{1}{6}\times\frac{6}{7}$	12. $\frac{1}{5}\times\frac{5}{6}$
	13. $\frac{1}{8}\times\frac{8}{9}$	14. $\frac{1}{7}\times\frac{7}{3}$	15. $\frac{1}{4}\times\frac{4}{5}$
	16. $\frac{1}{3}\times\frac{3}{4}$	17. $\frac{1}{2}\times\frac{2}{3}$	18. $\frac{1}{9}\times\frac{9}{10}$
J.	19. $\frac{2}{5}\times\frac{5}{8}$	20. $\frac{2}{9}\times\frac{3}{4}$	21. $\frac{4}{5}\times\frac{5}{8}$
	22. $\frac{5}{9}\times\frac{3}{5}$	23. $\frac{2}{3}\times\frac{3}{4}$	24. $\frac{5}{6}\times\frac{3}{20}$
	25. $\frac{4}{9}\times\frac{3}{8}$	26. $\frac{2}{5}\times\frac{5}{6}$	27. $\frac{8}{9}\times\frac{3}{16}$
K.	28. $\frac{5}{2}\times\frac{12}{5}$	29. $\frac{2}{3}\times\frac{15}{2}$	30. $\frac{3}{4}\times\frac{8}{3}$
	31. $\frac{7}{8}\times\frac{16}{7}$	32. $\frac{2}{3}\times\frac{9}{4}$	33. $\frac{5}{8}\times\frac{16}{5}$
	34. $\frac{3}{4}\times\frac{16}{3}$	35. $\frac{4}{5}\times\frac{15}{4}$	36. $\frac{4}{3}\times\frac{15}{2}$
L.	37. $\frac{7}{8}\times\frac{8}{7}$	38. $\frac{5}{9}\times\frac{9}{5}$	39. $\frac{3}{4}\times\frac{4}{3}$
	40. $\frac{2}{9}\times\frac{9}{2}$	41. $\frac{3}{8}\times\frac{8}{3}$	42. $\frac{8}{9}\times\frac{9}{8}$

NOTE. Groups *C*, *E*, and *F* represent the same types of difficulty as those found in the corresponding groups on page 95.

CHANGING MIXED NUMBERS TO FRACTIONS

Betty's mother has $2\frac{5}{6}$ peach pies. How many girls will this serve if each girl gets $\frac{1}{6}$ of a pie?

Change $2\frac{5}{6}$ to sixths. Since 1 whole pie $= \frac{6}{6}$ pie, then 2 whole pies $= \frac{12}{6}$ pies. Hence $2\frac{5}{6} = \frac{12}{6} + \frac{5}{6}$, or $\frac{17}{6}$.

Since there are 17 *sixths* in all, 17 girls can be served.

You see that to change $2\frac{5}{6}$ to $\frac{17}{6}$, you multiply 2 by 6 and add 5.

To change a mixed number to an improper fraction, multiply the whole number by the denominator, add the numerator, and place the result over the denominator.

Exercises

Reduce the following to improper fractions:

1. $2\frac{2}{3}$	**6.** $4\frac{1}{2}$	**11.** $4\frac{3}{8}$	**16.** $1\frac{3}{16}$	**21.** $4\frac{1}{3}$
2. $9\frac{1}{3}$	**7.** $2\frac{7}{8}$	**12.** $5\frac{5}{8}$	**17.** $5\frac{1}{5}$	**22.** $6\frac{1}{4}$
3. $1\frac{5}{6}$	**8.** $7\frac{3}{4}$	**13.** $5\frac{3}{4}$	**18.** $8\frac{3}{4}$	**23.** $3\frac{5}{6}$
4. $2\frac{7}{10}$	**9.** $7\frac{1}{4}$	**14.** $1\frac{1}{16}$	**19.** $2\frac{3}{4}$	**24.** $7\frac{2}{3}$
5. $6\frac{1}{2}$	**10.** $2\frac{2}{5}$	**15.** $3\frac{2}{5}$	**20.** $9\frac{1}{2}$	**25.** $1\frac{3}{5}$

26. In Jane's sewing class the children are making scarfs, using $\frac{1}{2}$ yd. of silk for each. How many scarfs can be made from a piece of silk $3\frac{1}{2}$ yd. long? 8 yd. long?

27. How many boxes of candy, each containing $\frac{1}{8}$ lb., can be filled from $2\frac{1}{8}$ lb. of candy? from $1\frac{5}{8}$ lb.? $2\frac{7}{8}$ lb.?

28. On a scale drawing of Henry's new house, $\frac{1}{2}$ in. represents 1 ft. If Henry's new room is $6\frac{1}{2}$ in. long and $4\frac{1}{2}$ in. wide on the drawing, how long and how wide is the room?

MULTIPLYING MIXED NUMBERS

1. Helen uses $\frac{2}{3}$ of a $3\frac{1}{2}$-pound bag of flour in making cake. How much flour does she use?

Change $3\frac{1}{2}$ to $\frac{7}{2}$. Then multiply $\frac{7}{2}$ by $\frac{2}{3}$. Always cancel when you can.

$$\frac{\cancel{2}}{3} \times \frac{7}{\cancel{2}} = \frac{7}{3} = 2\frac{1}{3}$$

You find that Helen uses $2\frac{1}{3}$ lb. of flour.

2. A farmer sows $3\frac{1}{2}$ qt. of clover seed on each acre of land. How many quarts does he need for $6\frac{2}{3}$ acres?

Change $3\frac{1}{2}$ to $\frac{7}{2}$ and $6\frac{2}{3}$ to $\frac{20}{3}$.

$$\frac{\overset{10}{\cancel{20}}}{3} \times \frac{7}{\cancel{2}} = \frac{70}{3} = 23\frac{1}{3}$$

To multiply a mixed number by a fraction or by another mixed number, first reduce each mixed number to an improper fraction and then multiply.

Problems

1. A recipe for cookies calls for $\frac{3}{4}$ lb. of sugar. Marie is making $2\frac{1}{2}$ times the amount of the recipe. How many pounds of sugar does she need?

2. A cake recipe calls for $1\frac{3}{4}$ cups of sugar. Louise is making $1\frac{1}{2}$ times the amount of the recipe. How many cups of sugar will she need?

3. How far can Mr. Jones travel in his car in $3\frac{1}{4}$ hr., if he averages $19\frac{1}{2}$ mi. an hour?

4. If Mr. Lane's car averages $17\frac{1}{2}$ mi. on 1 gal. of gasoline, how many miles can it go on $3\frac{1}{2}$ gal.?

5. There are $16\frac{1}{2}$ ft. in a rod. How many feet long is a fence that is $14\frac{2}{3}$ rd. long?

6. A farmer has $75\frac{1}{2}$ acres of wheat. How many bushels will he get if the average yield is $15\frac{3}{4}$ bu. per acre?

MULTIPLYING MIXED NUMBERS

Multiply. Check the work by going over it again:

Group			
A.	1. $\frac{2}{5}\times5\frac{1}{4}$	2. $\frac{2}{3}\times2\frac{1}{8}$	3. $\frac{3}{5}\times1\frac{5}{6}$
B.	4. $\frac{3}{4}\times3\frac{1}{5}$	5. $\frac{3}{5}\times7\frac{1}{2}$	6. $\frac{7}{8}\times5\frac{1}{3}$
C.	7. $\frac{1}{8}\times3\frac{1}{5}$	8. $\frac{4}{5}\times7\frac{1}{4}$	9. $\frac{1}{3}\times5\frac{1}{4}$
D.	10. $\frac{5}{6}\times2\frac{1}{4}$	11. $\frac{1}{4}\times3\frac{1}{3}$	12. $\frac{3}{8}\times1\frac{1}{5}$
F.	13. $3\frac{1}{8}\times\frac{4}{5}$	14. $1\frac{7}{8}\times\frac{2}{3}$	15. $4\frac{1}{6}\times\frac{3}{5}$
G.	16. $4\frac{1}{6}\times\frac{4}{5}$	17. $2\frac{2}{5}\times1\frac{5}{16}$	18. $1\frac{3}{5}\times\frac{5}{6}$
H.	19. $\frac{1}{5}\times6\frac{1}{4}$	20. $\frac{1}{8}\times2\frac{2}{3}$	21. $\frac{1}{2}\times3\frac{3}{5}$
J.	22. $1\frac{1}{3}\times\frac{3}{16}$	23. $1\frac{1}{3}\times\frac{3}{8}$	24. $1\frac{2}{3}\times\frac{3}{10}$
K.	25. $7\frac{1}{2}\times\frac{4}{5}$	26. $5\frac{1}{3}\times\frac{3}{4}$	27. $4\frac{2}{7}\times\frac{7}{16}$
A.	28. $2\frac{1}{8}\times1\frac{1}{3}$	29. $1\frac{1}{2}\times1\frac{1}{6}$	30. $1\frac{1}{2}\times1\frac{5}{6}$
B.	31. $2\frac{1}{4}\times1\frac{3}{5}$	32. $2\frac{1}{2}\times2\frac{2}{3}$	33. $4\frac{1}{2}\times1\frac{3}{5}$
D.	34. $7\frac{1}{5}\times2\frac{1}{8}$	35. $2\frac{1}{4}\times1\frac{1}{5}$	36. $1\frac{1}{4}\times3\frac{1}{3}$
F.	37. $1\frac{3}{5}\times1\frac{9}{16}$	38. $1\frac{1}{3}\times1\frac{7}{8}$	39. $1\frac{1}{3}\times1\frac{1}{8}$
G.	40. $1\frac{1}{4}\times1\frac{1}{5}$	41. $3\frac{3}{4}\times3\frac{1}{3}$	42. $6\frac{1}{4}\times3\frac{3}{5}$
K.	43. $8\frac{1}{3}\times2\frac{2}{5}$	44. $1\frac{2}{3}\times1\frac{4}{5}$	45. $7\frac{1}{2}\times1\frac{3}{5}$
	46. $4\frac{4}{5}\times1\frac{2}{3}$	47. $2\frac{1}{4}\times2\frac{2}{3}$	48. $4\frac{1}{2}\times5\frac{1}{3}$
L.	49. $2\frac{1}{2}\times\frac{2}{5}$	50. $1\frac{2}{3}\times\frac{3}{5}$	51. $2\frac{1}{4}\times\frac{4}{9}$

Note. The above groups for mixed numbers correspond to those on pages 95 and 97 for fractions. Thus, Group *A* represents the same type of difficulty on all three pages.

IMPROVEMENT TEST NO. 7

Test 7 A — Addition (Time 4 min.)

1. $2\frac{1}{2}$ + $7\frac{3}{4}$	2. $6\frac{1}{3}$ + $3\frac{2}{3}$	3. $9\frac{5}{8}$ + $6\frac{7}{8}$	4. $3\frac{1}{5}$ + $5\frac{1}{2}$
5. $2\frac{1}{2}$ + $4\frac{3}{8}$	6. $2\frac{2}{3}$ + $9\frac{1}{6}$	7. $1\frac{7}{8}$ + $4\frac{3}{4}$	8. $6\frac{1}{3}$ + $7\frac{1}{2}$
9. 4 + $9\frac{7}{12}$	10. $1\frac{3}{10}$ + $8\frac{7}{10}$	11. $8\frac{1}{10}$ + $5\frac{3}{5}$	12. $5\frac{1}{2}$ + $6\frac{9}{16}$

Test 7 B — Subtraction (Time 4 min.)

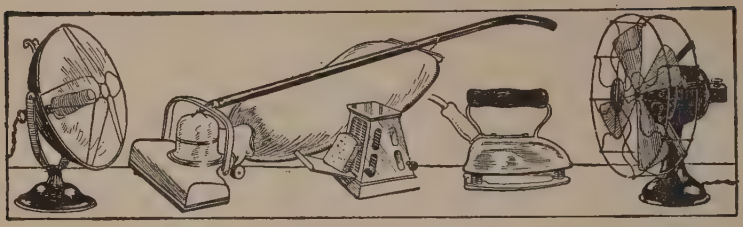
1. $4\frac{7}{8}$ − $2\frac{1}{8}$	2. $6\frac{3}{4}$ − $2\frac{1}{2}$	3. $2\frac{3}{4}$ − $2\frac{1}{3}$	4. 7 − $5\frac{3}{5}$
5. $5\frac{1}{3}$ − $1\frac{2}{3}$	6. $7\frac{1}{2}$ − $3\frac{1}{3}$	7. $6\frac{2}{5}$ − $1\frac{3}{10}$	8. $8\frac{1}{8}$ − $6\frac{5}{8}$
9. $9\frac{7}{16}$ − $4\frac{1}{2}$	10. $3\frac{7}{8}$ − $2\frac{5}{16}$	11. $8\frac{3}{4}$ − $3\frac{5}{12}$	12. $9\frac{7}{8}$ − $7\frac{11}{16}$

Test 7 C — Multiplication (Time 4 min. after copying)

1. $14\frac{7}{8}$ × 8	2. 164 × $3\frac{3}{4}$	3. 50 × $12\frac{3}{8}$
4. $\frac{2}{3}$ of 27	5. $\frac{9}{10} \times \frac{5}{8}$	6. $15 \times \frac{3}{4}$
7. $\frac{3}{16}$ of 52	8. $\frac{9}{16} \times 6\frac{2}{5}$	9. $3\frac{1}{5} \times 3\frac{3}{4}$

NOTE. For a test in the multiplication or division of fractions, like Test 7 C, first copy all the examples on paper, allowing sufficient space for working them. The time allowance does not include the time required for copying.

THE COST OF ELECTRICITY



John made this table to show his father what it costs per hour to run electrical appliances:

Appliance	*Cost per Hour for Electricity*
Toaster	5¢
Small electric fan (9 in.)	$\frac{1}{3}$¢
Large electric fan (16 in.)	$\frac{4}{5}$¢
Electric sewing machine	$\frac{3}{4}$¢
Vacuum cleaner	$1\frac{1}{3}$¢
Washing machine	$2\frac{1}{2}$¢
Small flatiron (3 lb.)	$3\frac{1}{3}$¢
Large flatiron (6 lb.)	$5\frac{1}{2}$¢
Electric heater	$5\frac{3}{4}$¢
Radio storage battery charger	$5\frac{2}{5}$¢

1. How much does the electricity cost to run a small electric fan for $3\frac{3}{4}$ hr.? If the fan is operated $2\frac{1}{2}$ hr. every evening, how much does it cost per week?

2. In making a dress, an electric sewing machine is used $1\frac{1}{3}$ hr. How much does the electricity cost?

3. John's mother uses a vacuum cleaner an average of $4\frac{1}{2}$ hr. a week. Find the weekly cost of running it.

4. How much does it cost per week to use an electric toaster $\frac{1}{4}$ hr. each morning?

5. John's sister uses an electric heater in her room on winter mornings. How much does it cost per week if she uses it $\frac{1}{2}$ hr. each morning? $\frac{1}{3}$ hr. each morning?

6. John's mother finds that with an electric washing machine she can do a week's washing in $2\frac{1}{3}$ hr., while it takes $3\frac{3}{4}$ hr. with a hand machine. How much time does the electric machine save in a week?

7. John uses a battery charger for $9\frac{1}{2}$ hr. on his radio batteries. How much does it cost for electricity?

8. John says, "It costs $7\frac{1}{3}$ times as much to operate a large electric flatiron as it does to run an electric sewing machine." Multiply $\frac{3}{4}$ by $7\frac{1}{3}$ and see if he is right. Do all the heating appliances cost more to operate than the power appliances?

9. A careless man went away on a vacation and left an electric light burning for 5 full days. At $\frac{3}{5}¢$ an hour, how much did this light cost for the 5 days?

10. A woman uses a vacuum cleaner $3\frac{1}{2}$ hr. a week, an electric washing machine $2\frac{1}{2}$ hr. a week, and a large flatiron $2\frac{3}{4}$ hr. a week. How much does it cost per week for electricity to operate the three appliances?

11. Make a table like John's to show the cost of operating each appliance $\frac{1}{2}$ hr.; $\frac{3}{4}$ hr.; $1\frac{1}{2}$ hr.; 2 hr.

12. In Fallstown, electricity costs only $\frac{2}{3}$ of what it costs where John lives; that is, the hourly cost of operating each appliance is $\frac{2}{3}$ of what John has in his table. Make a table like John's to show the cost of operating electrical appliances in Fallstown.

John's table on page 102 is based on a rate of 10¢ per kilowatt hour.

MAKING CANDY

1. To try this recipe, Ellen is making only half the amount. How much of each ingredient should she use?

Butterscotch

2 cups brown sugar
$\frac{1}{4}$ cup light corn sirup
1 cup water
$\frac{1}{4}$ teaspoon salt
$\frac{1}{3}$ cup butter
4 drops oil of lemon

2. How much of each ingredient should Julia use to make $2\frac{1}{2}$ times the amount of this recipe?

Plain Chocolate Caramels

$2\frac{1}{2}$ cups sugar
$\frac{3}{4}$ cup corn sirup
$\frac{1}{2}$ cup butter
$2\frac{1}{2}$ cups milk
$2\frac{1}{2}$ squares chocolate
1 teaspoon vanilla
$\frac{1}{8}$ teaspoon cream of tartar

3. The recipe below calls for 4 qt. of popcorn. John has only 3 qt. If he uses the 3 qt. for popcorn balls, how much of each of the other ingredients should he use?

Chocolate Popcorn Balls

$1\frac{1}{2}$ cups sugar
$\frac{1}{3}$ cup corn sirup
$\frac{2}{3}$ cup water
$\frac{1}{3}$ cup molasses
4 qt. popcorn, well salted
3 tablespoons butter
3 squares chocolate
1 teaspoon vanilla

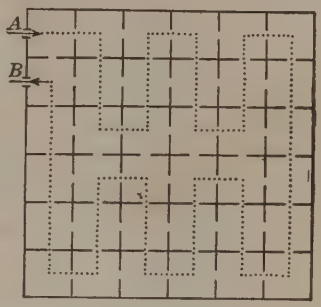
4. The following recipe will make 2 lb. of nut brittle. Write a new recipe to make 1 lb.; to make 3 lb.

Nut Brittle

2 cups granulated sugar
1 cup brown sugar
$\frac{1}{2}$ cup light corn sirup
$\frac{1}{2}$ cup water
$\frac{1}{4}$ cup butter
$\frac{1}{8}$ teaspoon soda
$\frac{1}{8}$ teaspoon salt
$1\frac{1}{2}$ cups nut meats

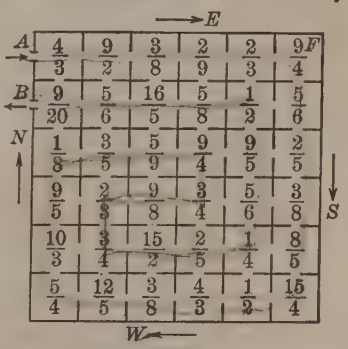
EXPLORING A DARK DUNGEON

Tom Sawyer told Huck Finn a quick way to explore a dark dungeon that has 36 cells. You must enter at *A*, walk through each cell once and *only once*, and leave at *B*. The dotted line shows one way to go; but this way requires 21 straight lines. It can be done with 11 straight lines. Copy the dungeon and try it.



Huck tried it, but the best he could do was with 13 lines. Then Tom gave him this secret code: E S W N E S W S E N W ($\times$ and turn at $\frac{3}{4}$)

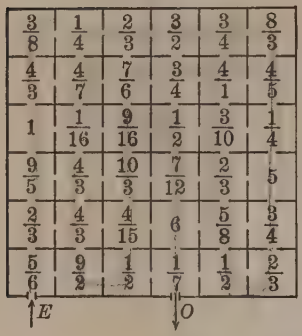
The code means that Huck must walk east (E) from *A*, multiplying the fractions on the way until he comes to $\frac{3}{4}$ or gets $\frac{3}{4}$ as an answer, like this: $\frac{4}{3} \times \frac{9}{2} = 6$, $6 \times \frac{3}{8} = \frac{9}{4}$, $\frac{9}{4} \times \frac{2}{9} = \frac{1}{2}$, $\frac{1}{2} \times \frac{2}{3} = \frac{1}{3}$, $\frac{1}{3} \times \frac{9}{4} = \frac{3}{4}$. At *F* he turns south (S) because the answer is $\frac{3}{4}$.



Beginning over again with $\frac{5}{6} \times \frac{2}{5} = \frac{1}{3}$, he keeps on until he gets $\frac{3}{4}$ again. Then he turns west (W). The letters in the code tell which way to turn each time.

Follow Tom's code to see if it takes only 11 straight lines. If you know another way that is just as short, try to make a code for it.

EXPLORING OTHER DUNGEONS

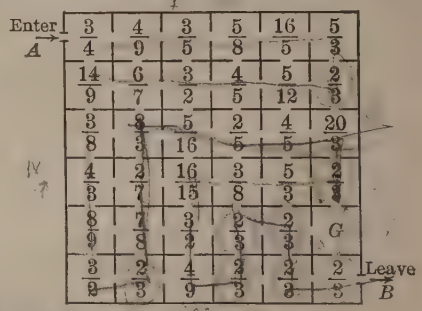


1. Here is another dungeon that Huck Finn found. You must go in at *E*, travel through every cell *once and only once*, and come out at *O*. If you can do this in 11 straight lines, you may carry off the treasure. Use this code to help you find the way:

N E S W N W S E N E S ($\times$ and turn at $\frac{1}{2}$)

$\times$ means "multiply." Multiply the fractions in the direction indicated in the code until you come to $\frac{1}{2}$ or get an answer of $\frac{1}{2}$. Then turn and follow the new direction until you get $\frac{1}{2}$ again.

2. In the dungeon at the right you enter at *A* and leave at *B*. Go into each cell once and only once, except the cell marked *G*, in which the guard is sleeping. Stay out of that cell. Go through the dungeon in as few straight lines as possible. Then see if this secret code gives a shorter way:



E S W S E N E S W S E N E S E ($\times$ and turn at $\frac{2}{3}$)

3. Try to find another way through the dungeon in ex. 1 that is as short as the one given. Make a code for it and let the rest of the class follow your code.

WINTER SPORTS

1. The weights of the six children on a bobsled are $62\frac{1}{2}$ lb., $85\frac{3}{4}$ lb., $91\frac{1}{8}$ lb., $41\frac{1}{4}$ lb., $78\frac{5}{8}$ lb., and $81\frac{1}{2}$ lb. What is the total weight on the sled?

2. Frank coasts on a hill 45 ft. long. Tony, who lives in the country, coasts on a hill 1629 ft. long. Tony's hill is how many times as long as Frank's?

3. There are 5280 ft. in a mile. The hill on which Amy goes coasting is 660 ft. long. Amy says that it is $\frac{660}{5280}$ of a mile long. Express this fraction in lowest terms.

4. It is $1\frac{3}{4}$ mi. around Shady Lake. If Ben skates around the lake 10 times a day, how far does he skate in a day? in 6 days?

5. Bill's ice boat has a mast $12\frac{1}{2}$ ft. high. Martin's is only $11\frac{2}{3}$ ft. high. How much taller is Bill's mast than Martin's?

6. Bill crosses the frozen bay in $\frac{1}{2}$ hr. in his ice boat. He stays on the other side $2\frac{1}{4}$ hr. and takes $\frac{3}{4}$ hr. to get back. How long is he gone in all?

7. A fast skater goes 1320 ft. in 38 sec. How many feet per second does he go?

8. Our snowman was $8\frac{3}{8}$ in. taller than Susan when we made him. Now he is only $4\frac{1}{2}$ in. taller than Susan. How much shorter has he grown?

REVIEW OF FRACTIONS

Add. Check the work by going over it again:

1.	2.	3.	4.	5.
$8\frac{3}{4}$	$3\frac{1}{3}$	$9\frac{3}{4}$	$7\frac{3}{8}$	$3\frac{4}{5}$
$2\frac{1}{8}$	$4\frac{5}{6}$	$1\frac{2}{3}$	$9\frac{3}{4}$	$5\frac{1}{2}$
$6\frac{1}{8}$	$7\frac{1}{2}$	$5\frac{3}{4}$	$2\frac{3}{16}$	$6\frac{3}{5}$

Subtract. Check the work by going over it again:

6.	7.	8.	9.	10.
$3\frac{5}{8}$	$9\frac{1}{4}$	$4\frac{3}{5}$	$8\frac{2}{3}$	$6\frac{1}{2}$
$2\frac{1}{4}$	$6\frac{3}{4}$	$1\frac{1}{10}$	$4\frac{5}{6}$	$5\frac{9}{16}$

Multiply. Check the work by going over it again:

11. $9 \times \frac{2}{3}$	18. $\frac{4}{7} \times 7$	25. $6\frac{1}{2} \times 3$	32. $12 \times 3\frac{1}{8}$
12. $6 \times \frac{3}{4}$	19. $\frac{1}{2} \times 5$	26. $3\frac{1}{2} \times 8$	33. $10 \times 1\frac{1}{2}$
13. $\frac{1}{2} \times \frac{4}{5}$	20. $\frac{5}{8} \times 6$	27. $2\frac{1}{6} \times 9$	34. $15 \times 2\frac{1}{4}$
14. $\frac{1}{4} \times \frac{1}{3}$	21. $\frac{3}{5} \times 2\frac{1}{2}$	28. $6\frac{1}{4} \times \frac{1}{5}$	35. $4\frac{3}{4} \times 7\frac{1}{2}$
15. $\frac{2}{9} \times \frac{9}{2}$	22. $\frac{7}{8} \times 5\frac{1}{3}$	29. $7\frac{1}{3} \times \frac{3}{4}$	36. $5\frac{7}{8} \times 64$
16. $\frac{3}{8} \times \frac{10}{9}$	23. $\frac{4}{5} \times 3\frac{3}{4}$	30. $1\frac{1}{2} \times \frac{1}{9}$	37. $4\frac{1}{2} \times 50$
17. $\frac{5}{6} \times \frac{3}{10}$	24. $\frac{8}{9} \times 5\frac{1}{4}$	31. $6\frac{3}{4} \times \frac{4}{9}$	38. $2\frac{3}{8} \times 75$

Multiply. Check the work by going over it again:

39.	40.	41.	42.	43.
460	207	135	$61\frac{3}{4}$	$89\frac{7}{8}$
$14\frac{1}{4}$	$85\frac{2}{3}$	$17\frac{1}{8}$	24	69

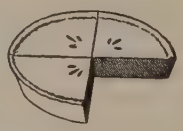
Divide and check. Express remainders as fractions in the quotients and reduce the fractions to lowest terms:

44. $1988 \div 56$	48. $5157 \div 216$	52. $8475 \div 175$
45. $3920 \div 42$	49. $9765 \div 420$	53. $9135 \div 630$
46. $4935 \div 75$	50. $6345 \div 675$	54. $2520 \div 576$
47. $1611 \div 27$	51. $9728 \div 768$	55. $6944 \div 896$

CHAPTER II

DIVIDING FRACTIONS

1. Alma has $\frac{3}{4}$ of a pie. She divides it into 3 equal pieces. Then each piece is what part of the pie?



Just as 3 *apples* $\div$ 3 = 1 *apple*, so 3 *fourths* $\div$ 3 = 1 *fourth;* that is, $\frac{3}{4} \div 3 = \frac{1}{4}$. You see that you divide the numerator of $\frac{3}{4}$ by 3 to get $\frac{1}{4}$.

2. If Mary divides $\frac{4}{5}$ of a pie equally between 2 boys, what part of the pie does each boy get?

To divide $\frac{4}{5}$ by 2, you divide the numerator of $\frac{4}{5}$ by 2 and get $\frac{2}{5}$. Each boy gets $\frac{2}{5}$ of a pie.

In these problems you see that the numerator of the fraction is exactly divisible by the whole number.

To divide a fraction by a whole number, divide the numerator, if it is exactly divisible, by the whole number.

Exercises

1. Mother divided $\frac{6}{8}$ of a cake among 3 girls. What part of a cake did each girl get? What is $\frac{6}{8} \div 3$?

Divide the following fractions mentally:

2. $\frac{3}{4} \div 3$	**6.** $\frac{4}{5} \div 4$	**10.** $\frac{15}{16} \div 5$	**14.** $\frac{8}{5} \div 2$
3. $\frac{5}{6} \div 5$	**7.** $\frac{3}{5} \div 3$	**11.** $\frac{14}{15} \div 2$	**15.** $\frac{9}{8} \div 3$
4. $\frac{8}{9} \div 8$	**8.** $\frac{4}{7} \div 2$	**12.** $\frac{9}{12} \div 3$	**16.** $\frac{8}{15} \div 4$
5. $\frac{10}{12} \div 2$	**9.** $\frac{6}{7} \div 2$	**13.** $\frac{9}{16} \div 9$	**17.** $\frac{15}{16} \div 3$

INVERTING A FRACTION

1. When you are asked to *invert* a fraction, such as $\frac{2}{3}$, turn it upside down like this: $\frac{3}{2}$. *To invert* means *to turn upside down.* What do you get if you invert $\frac{3}{4}$?

2. When you invert $\frac{1}{3}$ you get $\frac{3}{1}$, which equals 3. To invert 5, think of 5 as $\frac{5}{1}$, then turn $\frac{5}{1}$ upside down and get $\frac{1}{5}$. In the same way 17, or $\frac{17}{1}$, is $\frac{1}{17}$ when inverted.

Invert each of the following:

3. $\frac{3}{8}$ $\frac{1}{5}$ 3 $\frac{7}{8}$ $\frac{8}{1}$ 16 $\frac{5}{6}$ $\frac{6}{1}$ 7 $\frac{1}{6}$

DIVIDING A FRACTION BY A WHOLE NUMBER

The rule on page 109 tells you how to work an example like $\frac{3}{4} \div 3$. You will now learn how to divide a fraction by a whole number when the numerator of the fraction is not exactly divisible by the whole number.

1. Uncle Fred divides $\frac{1}{2}$ of a cake between Anna and John. What part of a cake does each get? What is $\frac{1}{2} \div 2$?

If you invert the divisor, 2, you get $\frac{1}{2}$. What is $\frac{1}{2} \times \frac{1}{2}$? Is $\frac{1}{2} \div 2$ the same as $\frac{1}{2} \times \frac{1}{2}$?

2. If Uncle Fred divides $\frac{1}{2}$ of a cake among 3 girls, what part of a cake does each get? What is $\frac{1}{2} \div 3$?

Invert 3 and find $\frac{1}{2} \times \frac{1}{3}$. Is $\frac{1}{2} \div 3$ the same as $\frac{1}{2} \times \frac{1}{3}$?

To divide a fraction by a whole number, invert the divisor and multiply.

This rule may be used for all problems. When the numerator of the fraction is exactly divisible by the whole number, it is quicker, however, to do the work mentally by using the rule on page 109.

DIVIDING A FRACTION BY A WHOLE NUMBER

Tell what fractions should be put in place of the dots:

1. $\frac{1}{3} \div 4 = \frac{1}{3} \times \frac{1}{4} = \ldots$
2. $\frac{1}{2} \div 3 = \frac{1}{2} \times \frac{1}{3} = \ldots$
3. $\frac{1}{5} \div 2 = \frac{1}{5} \times \ldots = \ldots$
4. $\frac{1}{4} \div 4 = \frac{1}{4} \times \ldots = \ldots$
5. $\frac{1}{2} \div 4 = \frac{1}{2} \times \ldots = \ldots$
6. $\frac{1}{3} \div 3 = \frac{1}{3} \times \ldots = \ldots$
7. $\frac{2}{3} \div 3 = \frac{2}{3} \times \ldots = \ldots$
8. $\frac{3}{4} \div 4 = \frac{3}{4} \times \ldots = \ldots$

9. Fay used $\frac{3}{4}$ lb. of flour for 2 cakes of equal size. What part of a pound of flour was there in each cake?

Since the numerator of $\frac{3}{4}$ is not divisible by 2, invert 2, which gives $\frac{1}{2}$; then multiply $\frac{3}{4}$ by $\frac{1}{2}$.

10. Aunt Susan divides $\frac{3}{4}$ lb. of candy equally among 6 girls. What part of a pound of candy does each get?

$$\frac{3}{4} \div 6 = \frac{\cancel{3}}{4} \times \frac{1}{\cancel{6}_{2}} = \frac{1}{8}$$

Always cancel when you can.
Each girl gets $\frac{1}{8}$ lb. of candy.

11. Anna has a whole pie and $\frac{1}{5}$ of another pie to divide among 3 girls. What is $\frac{6}{5} \div 3$? What part of a pie does each girl receive?

Divide. Do the work mentally when possible:

12. $\frac{2}{5} \div 4$
13. $\frac{3}{5} \div 6$
14. $\frac{2}{3} \div 6$
15. $\frac{5}{6} \div 10$
16. $\frac{3}{5} \div 3$
17. $\frac{8}{9} \div 2$
18. $\frac{8}{9} \div 3$
19. $\frac{15}{16} \div 5$
20. $\frac{2}{3} \div 8$
21. $\frac{3}{4} \div 3$
22. $\frac{4}{5} \div 8$
23. $\frac{3}{4} \div 9$
24. $\frac{8}{9} \div 6$
25. $\frac{8}{15} \div 2$
26. $\frac{7}{10} \div 7$
27. $\frac{15}{16} \div 6$
28. $\frac{4}{5} \div 6$
29. $\frac{14}{15} \div 4$
30. $\frac{9}{10} \div 6$
31. $\frac{4}{5} \div 10$
32. $\frac{5}{6} \div 15$
33. $\frac{2}{3} \div 18$
34. $\frac{4}{5} \div 16$
35. $\frac{15}{8} \div 3$
36. $\frac{4}{3} \div 2$
37. $\frac{8}{3} \div 2$
38. $\frac{3}{8} \div 9$
39. $\frac{8}{3} \div 4$
40. $\frac{8}{5} \div 4$
41. $\frac{15}{14} \div 5$
42. $\frac{18}{5} \div 6$
43. $\frac{21}{4} \div 7$

DIVIDING MIXED NUMBERS

Mrs. Smith used $9\frac{3}{4}$ yd. of narrow silk to make scarfs of equal length for 6 girls. How many yards long was each scarf?

$$9\tfrac{3}{4} \div 6 = \frac{\overset{13}{\cancel{39}}}{4} \times \frac{1}{\underset{2}{\cancel{6}}} = \frac{13}{8} = 1\tfrac{5}{8}$$

Change $9\frac{3}{4}$ to the improper fraction $\frac{39}{4}$. Invert the divisor, 6, to $\frac{1}{6}$ and then multiply. Check the work by going over it again.

Each scarf was $1\frac{5}{8}$ yd. long.

To divide a mixed number by a whole number, change the mixed number to an improper fraction and proceed as in dividing fractions.

Exercises

Divide. Check the work by going over it again:

1. $3\frac{1}{2} \div 3$	**10.** $2\frac{1}{4} \div 2$	**19.** $3\frac{2}{5} \div 3$	**28.** $5\frac{3}{4} \div 2$
2. $3\frac{2}{3} \div 4$	**11.** $5\frac{2}{3} \div 6$	**20.** $9\frac{1}{2} \div 4$	**29.** $1\frac{2}{3} \div 2$
3. $1\frac{1}{5} \div 4$	**12.** $4\frac{1}{2} \div 3$	**21.** $3\frac{1}{8} \div 5$	**30.** $3\frac{1}{3} \div 5$
4. $3\frac{3}{5} \div 6$	**13.** $1\frac{1}{6} \div 14$	**22.** $5\frac{1}{3} \div 4$	**31.** $4\frac{2}{3} \div 7$
5. $3\frac{1}{3} \div 4$	**14.** $7\frac{1}{2} \div 10$	**23.** $4\frac{7}{8} \div 6$	**32.** $2\frac{1}{5} \div 11$
6. $5\frac{1}{5} \div 13$	**15.** $1\frac{3}{5} \div 10$	**24.** $3\frac{3}{4} \div 6$	**33.** $2\frac{1}{4} \div 12$
7. $4\frac{4}{5} \div 16$	**16.** $7\frac{1}{2} \div 20$	**25.** $7\frac{1}{2} \div 18$	**34.** $6\frac{2}{3} \div 15$
8. $1\frac{1}{5} \div 12$	**17.** $2\frac{2}{3} \div 16$	**26.** $3\frac{1}{2} \div 42$	**35.** $1\frac{1}{4} \div 15$
9. $1\frac{2}{3} \div 10$	**18.** $11\frac{1}{5} \div 7$	**27.** $4\frac{2}{3} \div 14$	**36.** $17\frac{1}{2} \div 15$

37. Mary has $43\frac{1}{2}$ ft. of rope. She uses it to make 4 equal ropes for jumping. How long is each rope?

38. Arthur has picked $11\frac{1}{4}$ bu. of apples. If he puts them into 15 bags, each holding the same amount, what part of a bushel does he put into each bag?

39. It takes Carl 30 min. to go $3\frac{3}{4}$ mi. on his bicycle. What part of a mile does he average per minute?

WHAT IS YOUR AVERAGE?

1. Last week George kept a record of the time it took him to walk to school each day. It took him $10\frac{1}{2}$ min. on Monday, $9\frac{1}{4}$ min. on Tuesday, $9\frac{3}{4}$ min. on Wednesday, $10\frac{3}{4}$ min. on Thursday, and 11 min. on Friday. How many minutes a day, on the average, did it take him?

To find the average, add the 5 numbers and then divide the sum by 5. In doing this you will get a sum of $51\frac{1}{4}$, which must be changed to $\frac{205}{4}$ before you divide by 5.

2. Keep a record of the time it takes you to walk to school each day for a week. Find your average time.

3. Last September Jack weighed $72\frac{3}{4}$ lb. In 7 months his weight increased to 78 lb. How many pounds a month, on the average, did he gain?

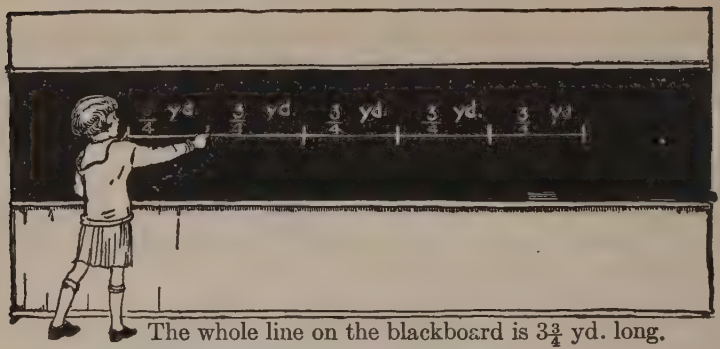
4. Jane gained $1\frac{1}{8}$ in. in height in 9 months. Find her average gain per month.

5. Fred has a pedometer, which shows how far he walks. On a trip to Echo Lake he walked $3\frac{7}{8}$ mi. the first hour, $3\frac{3}{4}$ mi. the second hour, and $3\frac{1}{4}$ mi. the third hour. How many miles an hour did he average?

6. In 5 days last week John spent $\frac{1}{3}$ hr., $\frac{1}{2}$ hr., $\frac{2}{3}$ hr., $\frac{1}{2}$ hr., and $1\frac{1}{3}$ hr. on his homework. Find the average time per day he spent on it.

7. Nell should practice on the piano $1\frac{1}{4}$ hr. each day except Sunday. Last week she practiced $\frac{5}{6}$ hr. on Monday, $1\frac{1}{4}$ hr. on Tuesday, $1\frac{1}{6}$ hr. on Wednesday, $\frac{3}{4}$ hr. on Thursday, $1\frac{3}{4}$ hr. on Friday, and $1\frac{1}{4}$ hr. on Saturday. Was her average time per day enough?

WHAT DIVIDING BY A FRACTION MEANS



The whole line on the blackboard is $3\frac{3}{4}$ yd. long.

1. Laura has a piece of ribbon 6 yd. long. To find how many pieces each 2 yd. long she can cut from it, she divides 6 by 2.

2. Suppose that Laura has a piece of ribbon $3\frac{3}{4}$ yd. long and wants to find how many pieces each $\frac{3}{4}$ yd. long she can cut from it. She must find how many times $\frac{3}{4}$ yd. is contained in $3\frac{3}{4}$ yd.; that is, she must divide $3\frac{3}{4}$ by $\frac{3}{4}$. To do this she draws a line $3\frac{3}{4}$ yd. long and measures off $\frac{3}{4}$ yd. on it as many times as she can, as shown in the picture. She measures 5 spaces, hence $3\frac{3}{4}$ yd. $\div$ $\frac{3}{4}$ yd. $= 5$.

3. Draw a line $3\frac{3}{4}$ in. long and mark it off into spaces each $\frac{3}{4}$ in. long. Do you get 5 spaces?

4. Bert says that he can get the same answer another way. He thinks of $3\frac{3}{4}$ in. as $\frac{15}{4}$ in. Then he thinks: 15 *fourths* $\div$ 3 *fourths* $= 15 \div 3$, or 5, just as 15 *feet* $\div$ 3 *feet* $= 5$. So Bert also shows that $\frac{15}{4} \div \frac{3}{4} = 5$.

5. You can divide by a fraction by measuring as Laura did or by thinking of the numbers as Bert did. On the next page you will learn a still shorter way to get the answer.

HOW TO DIVIDE BY A FRACTION

You have learned to divide a fraction by a *whole number* by inverting the divisor and multiplying. Now you will try this rule to divide *by a fraction.*

1. On page 114 Bert found that $\frac{15}{4} \div \frac{3}{4} = \frac{15}{3} = 5$. See if you can get the same answer by inverting $\frac{3}{4}$ to $\frac{4}{3}$ and multiplying, thus:

$$\frac{15}{4} \div \frac{3}{4} = \frac{15}{\cancel{4}_{1}} \times \frac{\cancel{4}^{1}}{3} = \frac{15}{3} = 5$$

The 4's cancel and you get the same result as before. This shows that the rule for dividing by inverting the divisor may be used also when you divide by a fraction.

2. Try the rule on a harder problem like $\frac{3}{4} \div \frac{2}{3}$.

You cannot divide 3 *fourths* by 2 *thirds* because they have *different names.* But if you change both fractions to *twelfths,* then they both have the *same name* and you can divide like this:

$$\frac{3}{4} \div \frac{2}{3} = \frac{9}{12} \div \frac{8}{12} = \frac{9}{8} = 1\tfrac{1}{8}$$

Now do the problem by inverting the divisor and multiplying *without changing the fractions to twelfths.* Invert $\frac{2}{3}$ and get $\frac{3}{2}$. Then multiply like this:

$$\frac{3}{4} \div \frac{2}{3} = \frac{3}{4} \times \frac{3}{2} = \frac{9}{8} = 1\tfrac{1}{8}$$

You get the same answer as you did before, and the second way to divide is *much quicker.*

To divide a fraction by a fraction, invert the divisor and multiply. Cancel, if possible, before multiplying.

DIVIDING BY A FRACTION

Study these examples carefully. Show how the divisor in each example is inverted.

$$\frac{7}{12} \div \frac{5}{8} = \frac{7}{\cancel{12}_{3}} \times \frac{\overset{2}{\cancel{8}}}{5} = \frac{14}{15} \qquad \frac{5}{12} \div \frac{5}{6} = \frac{\overset{1}{\cancel{5}}}{\cancel{12}_{2}} \times \frac{1}{\cancel{6}_{1}} = \frac{1}{2}$$

Exercises in Dividing Fractions

Group				
A'.	**1.** $\frac{3}{5} \div \frac{1}{2}$	**2.** $\frac{3}{4} \div \frac{2}{3}$	**3.** $\frac{1}{4} \div \frac{1}{3}$	**4.** $\frac{3}{10} \div \frac{2}{3}$
A.	**5.** $\frac{5}{8} \div \frac{3}{4}$	**6.** $\frac{9}{10} \div \frac{4}{5}$	**7.** $\frac{7}{16} \div \frac{3}{8}$	**8.** $\frac{11}{16} \div \frac{3}{4}$
B.	**9.** $\frac{3}{4} \div \frac{7}{8}$	**10.** $\frac{2}{3} \div \frac{5}{6}$	**11.** $\frac{5}{6} \div \frac{11}{12}$	**12.** $\frac{5}{8} \div \frac{7}{16}$
C.	**13.** $\frac{5}{6} \div \frac{5}{7}$	**14.** $\frac{7}{8} \div \frac{1}{4}$	**15.** $\frac{1}{5} \div \frac{3}{10}$	**16.** $\frac{1}{3} \div \frac{5}{12}$
D.	**17.** $\frac{8}{9} \div \frac{5}{6}$	**18.** $\frac{7}{8} \div \frac{5}{6}$	**19.** $\frac{5}{8} \div \frac{3}{10}$	**20.** $\frac{3}{8} \div \frac{5}{12}$
E.	**21.** $\frac{3}{4} \div \frac{1}{8}$	**22.** $\frac{3}{8} \div \frac{1}{16}$	**23.** $\frac{1}{5} \div \frac{1}{10}$	**24.** $\frac{1}{3} \div \frac{1}{15}$
F.	**25.** $\frac{2}{3} \div \frac{4}{9}$	**26.** $\frac{3}{4} \div \frac{9}{16}$	**27.** $\frac{5}{8} \div \frac{15}{16}$	**28.** $\frac{3}{10} \div \frac{9}{20}$
G.	**29.** $\frac{3}{8} \div \frac{9}{10}$	**30.** $\frac{8}{9} \div \frac{4}{15}$	**31.** $\frac{16}{25} \div \frac{14}{15}$	**32.** $\frac{5}{12} \div \frac{5}{8}$
H.	**33.** $\frac{1}{6} \div \frac{5}{6}$	**34.** $\frac{1}{8} \div \frac{3}{4}$	**35.** $\frac{1}{6} \div \frac{2}{3}$	**36.** $\frac{1}{8} \div \frac{7}{8}$
J.	**37.** $\frac{3}{8} \div \frac{3}{4}$	**38.** $\frac{2}{9} \div \frac{2}{3}$	**39.** $\frac{5}{12} \div \frac{5}{6}$	**40.** $\frac{7}{16} \div \frac{7}{8}$
K.	**41.** $\frac{3}{4} \div \frac{3}{8}$	**42.** $\frac{7}{8} \div \frac{7}{16}$	**43.** $\frac{5}{6} \div \frac{5}{12}$	**44.** $\frac{4}{5} \div \frac{4}{15}$

45. May has $\frac{3}{4}$ yd. of ribbon. How many badges each $\frac{1}{8}$ yd. long can she make from it?

46. Susan is making lemonade. She needs $\frac{3}{16}$ lb. of sugar for every quart of lemonade. She has 15 oz. ($\frac{15}{16}$ lb.) of sugar. How many quarts can she make?

NOTE. Each group above presents the same difficulty as is found in the corresponding group in multiplication on pages 95, 97, and 100.

HOW LONG DOES JOHN WALK?

1. John can walk $3\frac{1}{4}$ mi. an hour. How long does it take him to walk 13 mi.?

Write 13 as $\frac{13}{1}$ and $3\frac{1}{4}$ as $\frac{13}{4}$. Then invert $\frac{13}{4}$ to $\frac{4}{13}$ and multiply. The quotient is 4. Hence it takes John 4 hr.

$$13 \div 3\tfrac{1}{4} = \frac{13}{1} \div \frac{13}{4} = \frac{\overset{1}{\cancel{13}}}{1} \times \frac{4}{\underset{1}{\cancel{13}}} = 4$$

2. At $2\frac{1}{2}$ mi. an hour, how long would it take John to walk $13\frac{3}{4}$ mi.?

To divide a whole number or a mixed number by a fraction or by a mixed number, change all mixed numbers to improper fractions; then proceed as in dividing fractions.

TESTING THE RULE FOR DIVIDING

1. Alice made $7\frac{1}{2}$ lb. of candy for the school fair. How many boxes holding $\frac{3}{4}$ lb. each can she fill?

First invert the divisor and multiply, as shown here. Alice can fill 10 boxes.

$$7\tfrac{1}{2} \div \tfrac{3}{4} = \frac{\overset{5}{\cancel{15}}}{\underset{1}{\cancel{2}}} \times \frac{2}{\underset{1}{\cancel{3}}} = 10$$

To test the rule and check the answer, work the problem by changing pounds to ounces, as shown at the right. You get the same answer as before. Hence you know that the rule is right.

1 lb. = 16 oz.
$7\frac{1}{2}$ lb. = $7\frac{1}{2} \times 16$ oz. = 120 oz.
$\frac{3}{4}$ lb. = $\frac{3}{4} \times 16$ oz. = 12 oz.
120 oz. ÷ 12 oz. = 10

Divide by inverting the divisor and multiplying. Then test the rule by working each problem another way, changing yards to inches, pounds to ounces, and hours to minutes:

2. $2\frac{1}{2}$ yd. ÷ $\frac{1}{4}$ yd.
3. $3\frac{1}{4}$ hr. ÷ $\frac{1}{2}$ hr.
4. $6\frac{2}{3}$ hr. ÷ $\frac{5}{6}$ hr.
5. $5\frac{1}{3}$ yd. ÷ $\frac{2}{3}$ yd.
6. $3\frac{3}{8}$ lb. ÷ $\frac{3}{4}$ lb.
7. $5\frac{1}{4}$ lb. ÷ $\frac{7}{16}$ lb.
8. $6\frac{3}{4}$ yd. ÷ $\frac{3}{4}$ yd.
9. $3\frac{1}{2}$ hr. ÷ $\frac{3}{4}$ hr.
10. $3\frac{3}{4}$ lb. ÷ $\frac{5}{8}$ lb.

DIVIDING MIXED NUMBERS

Divide, and check. If you get any example wrong, practice all the examples in that group again.

Group			
A'.	1. $\frac{3}{5} \div 3\frac{1}{2}$	2. $7 \div \frac{2}{5}$	3. $8 \div 1\frac{1}{2}$
	4. $3\frac{1}{3} \div \frac{3}{4}$	5. $4\frac{1}{2} \div 1\frac{2}{3}$	6. $11 \div \frac{3}{4}$
A.	7. $\frac{5}{6} \div 4\frac{1}{2}$	8. $\frac{2}{3} \div 3\frac{1}{5}$	9. $\frac{3}{4} \div 1\frac{4}{5}$
	10. $1\frac{5}{8} \div \frac{3}{4}$	11. $5\frac{1}{4} \div 2\frac{1}{2}$	12. $1\frac{7}{8} \div 1\frac{3}{4}$
B.	13. $\frac{15}{16} \div 1\frac{2}{3}$	14. $4\frac{1}{5} \div \frac{3}{4}$	15. $5\frac{1}{3} \div 1\frac{3}{5}$
	16. $4\frac{3}{8} \div \frac{3}{16}$	17. $2\frac{5}{8} \div \frac{3}{5}$	18. $3\frac{1}{5} \div 2\frac{2}{3}$
C.	19. $\frac{3}{4} \div 1\frac{3}{4}$	20. $5 \div 7\frac{1}{2}$	21. $4 \div \frac{8}{9}$
	22. $6 \div 2\frac{2}{5}$	23. $1\frac{7}{8} \div \frac{7}{8}$	24. $2\frac{3}{4} \div 2\frac{1}{4}$
D.	25. $\frac{3}{4} \div 1\frac{1}{6}$	26. $6 \div 1\frac{3}{5}$	27. $15 \div \frac{6}{7}$
	28. $2\frac{1}{8} \div \frac{5}{12}$	29. $1\frac{5}{8} \div \frac{5}{12}$	30. $12\frac{1}{2} \div 3\frac{1}{3}$
E.	31. $21 \div 3\frac{1}{2}$	32. $35 \div \frac{5}{6}$	33. $18 \div 2\frac{1}{4}$
	34. $27 \div \frac{9}{10}$	35. $3\frac{3}{4} \div \frac{1}{8}$	36. $48 \div 9\frac{3}{5}$
F.	37. $\frac{3}{8} \div 1\frac{5}{16}$	38. $\frac{5}{9} \div 1\frac{7}{18}$	39. $1\frac{1}{2} \div \frac{15}{16}$
	40. $1\frac{9}{16} \div 1\frac{1}{4}$	41. $2\frac{1}{5} \div 1\frac{7}{15}$	42. $3\frac{1}{3} \div 2\frac{2}{9}$
G.	43. $\frac{14}{15} \div 5\frac{5}{6}$	44. $\frac{15}{16} \div 2\frac{11}{12}$	45. $2\frac{3}{16} \div \frac{5}{12}$
	46. $9\frac{1}{6} \div 1\frac{7}{15}$	47. $9\frac{3}{5} \div 1\frac{7}{25}$	48. $16\frac{1}{4} \div 3\frac{3}{4}$
H.	49. $\frac{1}{5} \div 3\frac{1}{5}$	50. $\frac{1}{6} \div 2\frac{2}{3}$	51. $\frac{1}{8} \div 6\frac{1}{4}$
	52. $\frac{1}{7} \div 1\frac{3}{7}$	53. $\frac{1}{9} \div 1\frac{2}{3}$	54. $\frac{1}{4} \div 1\frac{1}{2}$
J.	55. $\frac{4}{9} \div 5\frac{1}{3}$	56. $\frac{2}{3} \div 3\frac{1}{3}$	57. $\frac{7}{8} \div 5\frac{1}{4}$
	58. $1\frac{1}{3} \div 6\frac{2}{3}$	59. $2\frac{2}{3} \div 5\frac{1}{3}$	60. $4\frac{1}{5} \div 8\frac{2}{5}$
K.	61. $3\frac{3}{4} \div \frac{3}{16}$	62. $8\frac{1}{3} \div \frac{5}{6}$	63. $6\frac{3}{10} \div \frac{9}{10}$
L.	64. $3\frac{1}{4} \div \frac{13}{4}$	65. $1\frac{2}{3} \div \frac{5}{3}$	66. $1\frac{1}{4} \div \frac{5}{4}$

IMPROVEMENT TEST No. 8

Test 8 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.
5496	5769	9740	3585	4681
1237	4671	1912	1021	1047
8305	6944	6469	3925	6862
9458	3100	2900	1320	9765
1797	4366	9746	4893	8900
2608	5775	8088	5543	4092
3770	8828	3839	3709	2271

Test 8 B — Subtraction (Time 4 min.)

1. \$7830.73 − 564.17	2. \$9861.91 − 264.20	3. \$4967.20 − 648.12
4. \$8482.16 − 237.56	5. \$6529.04 − 1294.80	6. \$5209.35 − 2477.39
7. \$9675.39 − 3307.45	8. \$7540.33 − 5183.31	9. \$8317.12 − 4435.87
10. \$9697.09 − 2883.59	11. \$2097.15 − 1968.67	12. \$8214.65 − 1383.48

Test 8 C — Multiplication (Time 4 min. after copying)

1.	2.	3.	4.	5.
795 × 825	819 × 634	486 × 927	367 × 170	547 × 496

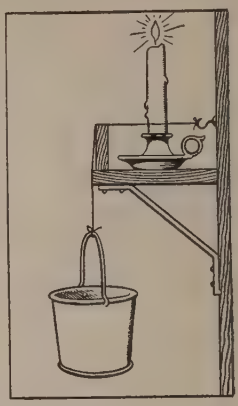
Test 8 D — Division (Time 4 min. after copying)

1. $73\overline{)34894}$ 2. $31\overline{)24583}$ 3. $59\overline{)48354}$

4. $56\overline{)14224}$ 5. $69\overline{)49664}$

HENRY'S ALARM CLOCK

Henry and John are camping. They want to get up early to go fishing. Henry says, "I will arrange a candle as in this sketch. When the flame reaches the string, the string will burn and the pail will drop and wake us."



1. Henry finds that a candle $7\frac{1}{8}$ in. long is only $4\frac{5}{8}$ in. long after burning 4 hr. How many inches burn away in 4 hr.? What part of an inch burns away each hour?

2. John says that a $6\frac{1}{2}$-inch candle will not burn over 6 hr. Henry says it will burn about 10 hr. If it burns at the rate of $\frac{5}{8}$ in. per hour, which boy is right?

3. If the boys want to sleep 8 hr., how far below the top of a $6\frac{1}{2}$-inch candle should they put the string?

4. How many inches from the top should they put the string if they want to sleep 7 hr.? $8\frac{1}{2}$ hr.? 9 hr.?

5. The boys decide to sleep $7\frac{1}{2}$ hr. To set the alarm clock, where do they put the string? At what time do they go to bed if they want to get up at 4.30? Their alarm clock works perfectly and the pail drops at 4.30.

6. Long ago people used to tell time by candles. If a candle burns at the rate of $\frac{3}{4}$ in. an hour, how long must it be to burn 8 hr.? $8\frac{1}{2}$ hr.? 10 hr.?

NOTE. The time candle, hour glass, burning rope, and water clock were all used by early peoples to measure time. They worked on the same principle as Henry's clock.

COMPARING A NUMBER WITH A SMALLER ONE

1. During vacation Tom earned \$36 and Edward, \$9. Tom earned how many times as much as Edward?

2. Ella is 15 yr. old. Her sister is 5 yr. old. Ella is how many times as old as her sister?

3. Ada had 75 words spelled right; but Sam had only 25 words right. Ada had how many times as many words right as Sam?

Tell what number should be put in place of the dots:

4. \$360 is . . . times as large as \$90.

5. 120 lb. is . . . times as heavy as 24 lb.

6. 96 in. is . . . times as long as 16 in.

To find how many times as great one number is as another, divide the larger number by the smaller one.

When you find that 75 lb. is 5 times as heavy as 15 lb., you *compare* 75 lb. with 15 lb.

Numbers may be compared by dividing one by the other.

Comparing Numbers by Division

1. Lucy picked 30 qt. of berries. Alice picked 12 qt. Show that Lucy picked $2\frac{1}{2}$ times as many quarts as Alice.

2. It is 92 mi. from New York to Philadelphia and 391 mi. from New York to Pittsburgh. Pittsburgh is how many times as far from New York as Philadelphia?

In each problem, compare the numbers, stating how many times as large the first number is as the second:

3. 240 and 60
4. 180 and 24
5. 396 and 176
6. 440 and 80
7. 250 and 100
8. 300 and 100
9. 112 and 48
10. 1970 and 788
11. 1440 and 320

WORKING PROBLEMS BY COMPARING NUMBERS

When oranges sell at 4 for 25¢, how many oranges can you buy for 75¢?

Since 75¢ is 3 times 25¢, you can buy 3 times as many oranges for 75¢ as for 25¢. If you get 4 oranges for 25¢, you get 3×4 oranges, or 12 oranges, for 75¢.

Exercises

1. Ray's mother pays 15¢ for 25 lb. of ice. At this rate, how much does she pay for 50 lb. of ice?

2. If the baker sells 3 muffins for 10¢, how much do 1 doz. muffins cost?

3. Jackstones are selling at 2 for 3¢. Maud wants to buy 8 jackstones. How much will they cost?

4. Apples are selling at 8 for 25¢. How many apples can you get for 75¢?

5. It cost Billy 85¢ to feed his dog for 4 wk. How much will it cost to feed him for 12 wk.?

6. How much will 10 pads cost at 2 pads for 15¢?

7. Ted pays $5 to rent a canoe for 2 wk. At this rate, how much must he pay to rent one for 6 wk.?

8. When peaches are selling at 2 lb. for 15¢, how many pounds of peaches can Mrs. Foster buy for 60¢?

9. Mrs. Brown used $3\frac{1}{2}$ doz. eggs in 2 wk. At this rate, how many dozen eggs would she use in 8 wk.?

10. Janet paid 28¢ for some apples. How many did she get if apples were selling at 2 for 7¢?

11. How much do 9 bananas cost at 6 for 20¢?

12. Sam earned 50¢ for working 3 hr. How long would he have to work to earn 75¢?

ANOTHER WAY TO COMPARE NUMBERS

When you compare a number with a smaller one, you ask this question: *The larger number is how many times as great as the smaller one?* When you compare a number with a larger one, you ask a different question: *The smaller number is what part of the larger one?* To compare 6¢ with 12¢, think: "6¢ is what part of 12¢?" You see that 6¢ is $\frac{1}{2}$ of 12¢.

Exercises

1. Mary buys 3 eggs. What part of a dozen is that?

2. Ada has 4 cakes. What part of a dozen is that?

3. What part of a dozen is 5 oranges? 7 oranges?

4. What part of an hour is 7 min.? 29 min.?

5. What part of a yard is 5 in.? 7 in.? 25 in.?

6. Agnes needs 27 in. of ribbon. Show that she needs $\frac{3}{4}$ yd. of ribbon.

Since 1 in. $= \frac{1}{36}$ of 1 yd., 27 in. $= \frac{27}{36}$ of 1 yd. Reduce $\frac{27}{36}$ to $\frac{3}{4}$.

7. What part of a yard is 24 in.? 32 in.? 28 in.? 20 in.? Reduce each fraction to lowest terms.

8. Carl takes 16 sec. to run 100 yd.; Bob takes 20 sec. What part of a minute does each boy take?

9. Toby had $18 and spent $12. What part of his money did he spend?

10. Fred had 35 marbles. He gave 15 marbles away. What part of his marbles did he give away?

To find what part one number is of a larger number, write the smaller number over the larger one to make a fraction. Reduce the fraction to lowest terms.

FINDING WHAT PART ONE NUMBER IS OF ANOTHER

1. Dick earns \$15 a week and saves \$6 each week. What part of the \$15 does he save?

2. Edna earns \$75 during the summer and saves \$45. What part of her earnings does she save?

3. In a 50-word spelling test, May gets 45 words right. What part of the test does May get right?

4. Out of the 24 hr. of each school day, Edith sleeps 11 hr., goes to school 6 hr., plays 2 hr., studies at home 1 hr., and spends the rest of the time at meals, dressing, and other things. She spends what part of the day in sleep? at school? in play? in home study? at meals and other things?

5. Gene is taking a summer course that lasts 30 days. What part of the term is over at the end of the first day? the second day? the third day? the fourth day? the fifth day? the sixth day? the tenth day?

6. The Reds win 21 games out of 24 baseball games. The Indians win 15 games out of 20 games. What part of the games it plays does each team win? Which team does better?

7. Mr. Lott is driving 135 mi. He has already driven 90 mi. What part of the distance has he gone?

To reduce a large fraction like $\frac{90}{135}$, use the divisibility tests on pages 77 and 78.

8. The Cox School has 528 pupils. One day 132 pupils go on a picnic. What part of the pupils go on the picnic?

9. On Field Day Raymond runs in the 220-yard dash. What part of a mile does he run? (1 mi. = 1760 yd.)

FINDING WHAT PART ONE NUMBER IS OF ANOTHER

1. Daisy had to hem 36 napkins. As she finished the first, she said, "$\frac{1}{36}$ of this job is done." What did she say as she finished each of the other napkins?

Compare these numbers by finding what part the smaller number is of the larger one:

2. 15 and 45	**7.** 35 and 40	**12.** 175 and 350
3. 24 and 60	**8.** 16 and 72	**13.** 126 and 567
4. 50 and 75	**9.** 75 and 90	**14.** 108 and 288
5. 48 and 120	**10.** 110 and 165	**15.** 185 and 555
6. 75 and 325	**11.** 105 and 140	**16.** 402 and 603

SHARING THINGS

1. Mr. Low pays Ed and Joe \$1.75 for weeding his garden. What part of the \$1.75 does each boy get if Joe works 2 hr. and Ed, 3 hr.? How much does each get?

The boys work 5 hr. in all. Since Joe works 2 hr., he gets $\frac{2}{5}$ of the \$1.75. Since Ed works 3 hr., he gets $\frac{3}{5}$ of the \$1.75.

2. Paul and Ben buy 100 marbles for 60¢. Paul pays 45¢ and Ben, 15¢. How many marbles does each get?

3. Mary and Alice together are paid \$2.00 for taking care of Mrs. Drew's baby. Mary looks after the baby for 6 hr. and Alice, for 4 hr. How should they divide the \$2.00? How much is each girl's share?

4. Mr. Carter and Mr. Lee together rent a 7-passenger car for \$17.50. Mr. Carter invites 3 of his friends to go along, while Mr. Lee invites 2 of his friends. What is Mr. Carter's share of the expense? Mr. Lee's share?

FINDING THE WHOLE WHEN A PART IS KNOWN

1. Louise paid 13¢ for $\frac{1}{4}$ lb. of butter. At this rate, how much would 1 lb. of butter cost?

2. Bert spent 75¢ on lunches last week. This was $\frac{1}{2}$ of his allowance. What was his allowance?

3. Tim had \$7.50, which was $\frac{1}{3}$ of what he needed to buy a bicycle. How much did the bicycle cost?

Tell what numbers should be put in place of the dots:

4. 5 is $\frac{1}{2}$ of ···

5. 8 is $\frac{1}{4}$ of ···

6. 7 is $\frac{1}{3}$ of ···

7. 6 is $\frac{1}{6}$ of ···

8. 10 is $\frac{1}{5}$ of ···

9. 15 is $\frac{1}{3}$ of ···

10. 25 is $\frac{1}{6}$ of ···

11. 20 is $\frac{1}{4}$ of ···

12. 17 is $\frac{1}{3}$ of ···

13. 18 is $\frac{1}{9}$ of ···

14. 25 is $\frac{1}{8}$ of ···

15. 80 is $\frac{1}{4}$ of ···

Harder Exercises

1. If $\frac{3}{4}$ lb. of nuts costs 24¢, how much does 1 lb. cost?

$\frac{3}{4}$ lb. costs 24¢. Then $\frac{1}{4}$ lb. costs $\frac{1}{3}$ of 24¢, or 8¢, and 1 lb., or $\frac{4}{4}$ lb., costs 4×8¢, or 32¢. To check, take $\frac{3}{4}$ of 32¢ and you get 24¢.

2. Will found that $\frac{3}{4}$ of a watermelon weighed 18 lb. How much did the whole melon weigh?

3. "Owing to a storm, only $\frac{2}{5}$ of the scouts in York were at the rally. The 24 boys who came had a fine time." From this report, tell how many scouts York has.

4. Jack bought a radio set for \$22.50, which was $\frac{3}{4}$ of the regular price. What was the regular price?

Tell what number should be put in place of the dots:

5. 8 is $\frac{2}{3}$ of ···

6. 15 is $\frac{3}{5}$ of ···

7. 21 is $\frac{3}{4}$ of ···

8. 27 is $\frac{3}{8}$ of ···

9. 33 is $\frac{3}{4}$ of ···

10. 40 is $\frac{2}{3}$ of ···

11. 45 is $\frac{5}{8}$ of ··

12. 42 is $\frac{7}{8}$ of ···

13. 80 is $\frac{2}{5}$ of ···

PARTS OF A DOLLAR

1. When 3 golf balls cost \$1.00, how much does each ball cost? $\frac{1}{3}$ of \$1.00 equals how many cents?

2. What part of a dollar is 25¢? 50¢? 75¢?

3. How many cents are there in $\frac{1}{8}$ of \$1.00? If you buy 2 notebooks for 25¢, how much does each cost? Then each notebook costs what part of a dollar?

4. If you buy 16 glasses at 2 for 25¢, or $12\frac{1}{2}$¢ each, the total cost is $16 \times 12\frac{1}{2}$¢; but if you remember that $12\frac{1}{2}$¢ = $\$\frac{1}{8}$, it is much quicker to find $16 \times \$\frac{1}{8}$, which gives $\$\frac{16}{8}$, or \$2. You can often shorten the work by canceling.

5. How many cents are there in $\frac{3}{8}$ of \$1.00? If you buy 2 handkerchiefs for 75¢, how much does each cost? Then each handkerchief costs what part of a dollar?

6. Memorize the following **fractional parts** of a dollar:

50¢ = $\frac{1}{2}$ of \$1	$33\frac{1}{3}$¢ = $\frac{1}{3}$ of \$1	$12\frac{1}{2}$¢ = $\frac{1}{8}$ of \$1
25¢ = $\frac{1}{4}$ of \$1	$66\frac{2}{3}$¢ = $\frac{2}{3}$ of \$1	$37\frac{1}{2}$¢ = $\frac{3}{8}$ of \$1
75¢ = $\frac{3}{4}$ of \$1	$16\frac{2}{3}$¢ = $\frac{1}{6}$ of \$1	$62\frac{1}{2}$¢ = $\frac{5}{8}$ of \$1
20¢ = $\frac{1}{5}$ of \$1	$83\frac{1}{3}$¢ = $\frac{5}{6}$ of \$1	$87\frac{1}{2}$¢ = $\frac{7}{8}$ of \$1

$12\frac{1}{2}$¢, $16\frac{2}{3}$¢, 20¢, 25¢, $33\frac{1}{3}$¢, and 50¢ are called **aliquot parts** of \$1.00 because each divides \$1.00 exactly; but $37\frac{1}{2}$¢, $62\frac{1}{2}$¢, $66\frac{2}{3}$¢, 75¢, $83\frac{1}{3}$¢, and $87\frac{1}{2}$¢ are not aliquot parts.

7. If 6 handkerchiefs cost \$1.00, find the cost of each.

8. Remembering that $16\frac{2}{3}$¢ = $\frac{1}{6}$ of \$1, find the cost of 18 handkerchiefs at $16\frac{2}{3}$¢ each; of 24 handkerchiefs.

9. Find the cost of 16 tennis balls at 50¢ each.

10. Find the cost of 20 batteries at 25¢ each.

11. How much will 12 baseballs cost at 75¢ each?

MAKING PURCHASES

1. At a sale, tennis balls sell for $33\frac{1}{3}¢$ each. How much must Fred pay for 6 balls?

2. Mary needs 8 yd. of lace to trim a centerpiece. At $12\frac{1}{2}¢$ a yard, how much will the lace cost her?

3. David bought 4 doz. small plants at 25¢ apiece for his garden. Find his bill for these plants.

4. Our teacher bought a paint set for each of her 40 pupils. At $37\frac{1}{2}¢$ each, how much did the sets cost?

5. For the school play 384 tickets were sold at 75¢ apiece and 160 tickets at 50¢ apiece. How much money was collected from the sale of tickets?

6. A dealer buys oranges at 25¢ a dozen. How much will he pay for 48 doz.?

7. At a book sale Mr. Evans bought 7 books for 50¢ apiece. How much did these books cost him?

8. Ned bought 12 yd. of canvas at 75¢ a yard to make a tent. How much did he have to pay for the canvas?

Find the following, using parts of a dollar:

9. $60\times50¢$	**18.** $132\times25¢$	**27.** $295\times20¢$
10. $96\times25¢$	**19.** $256\times75¢$	**28.** $258\times50¢$
11. $44\times25¢$	**20.** $190\times50¢$	**29.** $464\times25¢$
12. $90\times20¢$	**21.** $250\times50¢$	**30.** $500\times75¢$
13. $56\times12\frac{1}{2}¢$	**22.** $64\times12\frac{1}{2}¢$	**31.** $50\times25¢$
14. $27\times33\frac{1}{3}¢$	**23.** $69\times33\frac{1}{3}¢$	**32.** $160\times75¢$
15. $72\times16\frac{2}{3}¢$	**24.** $90\times16\frac{2}{3}¢$	**33.** $813\times33\frac{1}{3}¢$
16. $32\times62\frac{1}{2}¢$	**25.** $240\times87\frac{1}{2}¢$	**34.** $531\times66\frac{2}{3}¢$
17. $75\times66\frac{2}{3}¢$	**26.** $176\times37\frac{1}{2}¢$	**35.** $300\times33\frac{1}{3}¢$

IMPROVEMENT TEST NO. 9

Test 9 A — Addition (Time 4 min.)

1. $5\frac{3}{8}$ + $6\frac{7}{8}$	**2.** $7\frac{3}{4}$ + $2\frac{3}{8}$	**3.** $1\frac{3}{5}$ + $4\frac{1}{2}$	**4.** $8\frac{1}{6}$ + $9\frac{1}{6}$
5. $2\frac{3}{4}$ + $\frac{1}{8}$	**6.** $7\frac{1}{2}$ + $3\frac{1}{2}$	**7.** $9\frac{1}{4}$ + $8\frac{3}{5}$	**8.** $7\frac{1}{3}$ + $9\frac{3}{4}$
9. $4\frac{3}{16}$ + $5\frac{5}{8}$	**10.** $6\frac{1}{5}$ + $\frac{9}{10}$	**11.** $3\frac{5}{12}$ + $1\frac{3}{4}$	**12.** $5\frac{2}{3}$ + $2\frac{7}{12}$

Test 9 B — Multiplication (Time 4 min. after copying)

1. $18\frac{1}{2}$ × 27	**2.** $66\frac{2}{3}$ × 18	**3.** 46 × $12\frac{3}{4}$
4. $\frac{5}{2} \times \frac{3}{8}$	**5.** $4\frac{4}{5} \times \frac{15}{16}$	**6.** $32 \times \frac{5}{8}$
7. $\frac{15}{16} \times \frac{8}{25}$	**8.** $2\frac{1}{2} \times \frac{2}{15}$	**9.** $12 \times 4\frac{5}{12}$

Test 9 C — Division (Time 4 min. after copying)

1. $2\frac{1}{2} \div 4$	**2.** $\frac{9}{16} \div \frac{5}{8}$	**3.** $2\frac{5}{8} \div \frac{3}{4}$
4. $6\frac{1}{4} \div 5$	**5.** $\frac{15}{16} \div \frac{5}{12}$	**6.** $1\frac{5}{6} \div \frac{1}{2}$
7. $8 \div 2\frac{2}{3}$	**8.** $\frac{7}{10} \div 3\frac{1}{2}$	**9.** $1\frac{1}{3} \div 5\frac{1}{3}$

NOTE. Copy tests in the multiplication or division of fractions, such as Tests 9 B and 9 C, before starting to work them. The time allowance does not include the time required for copying.

MEASURES

Learning About Units of Measure

You have learned how to measure lengths with a foot rule and a yardstick. In measuring a small object, like a pencil, the length is found in *inches*. In such a case the *inch* is the **unit of measure.** When the length of a longer object, like a blackboard, is found in *feet*, the *foot* is the unit of measure. Similarly, when the length of a roll of ribbon is measured in *yards*, and the distance between two cities in *miles*, yards and miles are the units of measure.

The most convenient unit of measure should always be selected. The length of the schoolyard should not be measured in *inches* because it would take too long. Likewise the length of a book should not be found in feet because the foot is too large a unit for this purpose.

There are also several different units for measuring weight, liquids, and time. A family buys milk by the *quart* and ice by the *pound*, while a large hotel buys milk by the *gallon* and ice by the *ton*. It is very convenient to have different units of measure.

Tell what unit of measure you use to find:

The height of a door.
The length of a carpet.
The length of a house.
The thickness of a board.
The weight of a ship.
The length of a road.
The weight of a man.
The length of a candle.
The amount of coal you burn each winter.
The amount of ice cream needed for 8 people.
The distance from Chicago to San Francisco.
The amount of gasoline used on an automobile trip.

HOW LENGTH IS MEASURED

Memorize this table of *length:*

12 inches (in.)	= 1 foot (ft.)
3 feet	= 1 yard (yd.)
$5\frac{1}{2}$ yards or $16\frac{1}{2}$ feet	= 1 rod (rd.)
320 rods or 5280 feet	= 1 mile (mi.)

Exercises

1. The above table shows that $5\frac{1}{2}$ yd. or $16\frac{1}{2}$ ft. equal 1 rd. Show that $5\frac{1}{2}$ yd. = $16\frac{1}{2}$ ft.

2. The table shows also that 320 rd. or 5280 ft. equal 1 mi. Show that 320 rd. = 5280 ft.

3. What part of a yard is 18 in.? 9 in.? 24 in.?

4. Mary needs 4 yd. 18 in. of ribbon and 27 in. of silk. How many yards of each should she ask for?

5. What part of a foot is 6 in.? 2 in.? 4 in.? 3 in.? 8 in.? 9 in.?

6. Ann is 4 ft. 9 in. tall. Give her height in feet.

7. What part of a mile is 40 rd.? 80 rd.? 160 rd.?

8. What part of a mile is 528 ft.?

9. With a rope 1 rd. long, how can you measure off $\frac{1}{10}$ mi. along the street?

10. Suppose that you are having a $\frac{1}{4}$-mile race. How many feet are there in $\frac{1}{4}$ mi.? If you have a yardstick and a cord 100 ft. long, how can you measure off $\frac{1}{4}$ mi.?

11. How many yards are there in 1 mi.? What part of a mile do you run if you run in a 220-yard dash? in a 440-yard dash?

COMPARING LENGTHS

You often have to compare one length with another. If Lena is 47 in. tall and Jack is 4 ft. tall, you must express their heights in the same unit before you can tell who is taller. If you change 4 ft. to 48 in., then you can easily compare 47 in. and 48 in. and see that Jack is taller.

To compare two lengths, express them in the same unit.

Exercises

1. Wilbur is 61 in. tall and Joe is 4 ft. 11 in. tall. Tell which of the boys is taller, and how much taller.

2. Sarah needs $1\frac{3}{4}$ yd. of ribbon. Her mother has a piece 1 yd. 25 in. long. Is that piece long enough?

3. Robert read in the newspaper that an airplane which he saw last summer flew to a height of 16,240 ft. This fall he saw one which flew to a height of $3\frac{1}{2}$ mi. Which airplane flew higher? how much higher?

4. George Washington was once a surveyor. When he measured land, he used a unit called a *chain*, which equals 66 ft. How many rods equal 1 chain? How many chains equal 1 mi.?

5. In an old deed a certain piece of land was described as 20 chains long and 16 chains wide. In another deed the same land was described as 80 rd. long and 60 rd. wide. Did the two deeds agree?

6. Pat said that Mt. Everest, the highest mountain in the world, is 6 mi. high. Edna's geography gave the height as 29,141 ft. Was Pat right? Which would have been nearest right, $5\frac{1}{4}$ mi., $5\frac{1}{2}$ mi., or $5\frac{3}{4}$ mi.?

MEASURING DISTANCES

1. Arthur must go 8 times around the running track on the playground to run a mile. What is the distance around the track in yards?

2. Joe goes 22 times around a running track to make a mile. Find the distance around the track in feet.

3. In a race a man ran 32 times around a 660-foot race track. How many miles did he run?

4. Mark's steps average $2\frac{1}{4}$ ft. If he takes 1760 steps in walking to school, how far from school does he live? What part of a mile is that?

5. If a kangaroo jumps 55 ft. in each leap, in how many leaps would it travel a mile?

6. If a grasshopper that is $1\frac{3}{4}$ in. long can jump 200 times its length, how many feet can it jump?

Other Problems

1. Fred needs 4 boards, each $2\frac{1}{2}$ ft. long, to make some shelves. Find the cost of these boards at $8\frac{1}{2}¢$ a foot.

2. If a man walks $3\frac{1}{2}$ mi. an hour, how long will it take him to make a trip of 28 mi.?

3. If a pound of cotton yarn makes $5\frac{1}{2}$ yd. of gingham, how many yards of gingham will 250 lb. of yarn make?

Tell what numbers should be put in place of the dots:

4. $1\frac{1}{2}$ ft. = . . . in.

5. $\frac{3}{4}$ yd. = . . . in.

6. $\frac{1}{2}$ rd. = . . . ft.

7. 9 in. = . . . ft.

8. 18 in. = . . . yd.

9. $1\frac{1}{2}$ yd. = . . . ft.

10. Write these in order of their size, with the largest first: 42,240 in., 3960 ft., $\frac{5}{8}$ mi., 1056 yd.

LIQUID MEASURE

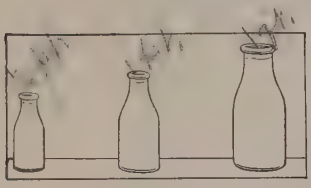
Our units of liquid measure are the pint, the quart, and the gallon. We buy milk by the pint and the quart, and gasoline by the gallon.

Memorize this table of *liquid measure:*

2 pints (pt.) = 1 quart (qt.)
4 quarts = 1 gallon (gal.)

Exercises

1. The three standard sizes of milk bottles are shown here. The largest holds 1 qt. How much do the others hold?



2. Name ten things that are sold by liquid measure. Tell whether each is sold by the pint, the quart, or the gallon.

3. How many pints are there in 3 qt.? in $2\frac{1}{2}$ qt.? in $8\frac{1}{2}$ qt.? in 1 gal.? in $2\frac{1}{2}$ gal.?

4. Ten gallons of milk will fill how many quart bottles? how many pint bottles? how many $\frac{1}{2}$-pint bottles?

5. What part of a gallon is a quart? a pint?

6. The average barrel holds $31\frac{1}{2}$ gal. How many quart bottles will 1 barrel of vinegar fill?

7. See how many glasses you can fill with 1 qt. of water. How many glassfuls make 1 pt.? $\frac{1}{2}$ pt.?

8. Yesterday Fred sold $6\frac{1}{2}$ qt. of lemonade. How many glassfuls did he sell? At 5¢ a glass, how much money did he take in?

MEASURING FRUITS AND GRAINS

Fruits, grains, and vegetables are measured by the pint, the quart, the peck, and the bushel. You may buy a pint or a quart of berries, a peck of potatoes, or a bushel of apples.

Memorize this table of *dry measure:*

2 pints (pt.) = 1 quart (qt.)
8 quarts = 1 peck (pk.)
4 pecks = 1 bushel (bu.)

Vegetables, fruits, and grains are also sold by the pound. Thus, 60 pounds of wheat are called a bushel.

Exercises

1. How many quarts are there in 1 bu.? in 6 bu.? in $2\frac{1}{2}$ bu.? in 3 pk.? in $4\frac{1}{2}$ pk.? in 8 pt.?

2. How many bushels are there in 12 pk.? in 20 pk.? in 32 qt.? in 96 qt.? in 208 qt.?

3. Will bought 12 qt. of cherries. What part of a bushel did he buy?

4. A farmer feeds 12 qt. of feed to his horses each day. How many days will 18 bu. last?

5. Sam bought $2\frac{1}{2}$ bu. of cherries at \$5.30 a bushel and sold them at 27¢ a quart. Find his total profit.

6. Dan's father plants 7 pk. of wheat per acre. How many bushels of wheat must he buy for a 24-acre field?

7. How many pint boxes will 1 bu. of raspberries fill?

8. Find the profit on $12\frac{1}{2}$ bu. of apples bought at \$1.45 a bushel and sold in 4-quart baskets at 35¢ a basket.

HOW WEIGHT IS MEASURED

The units of weight are the ounce, the pound, the hundredweight, and the ton. You may buy spices by the ounce, and butter and meat by the pound. Freight and express rates are usually given by the hundredweight, which is also used in buying grain and cotton and in selling milk to creameries. The ton is used to weigh things bought in large quantities, like coal and ice.

Memorize this table of *weight:*

16 ounces (oz.) = 1 pound (lb.)
100 pounds = 1 hundredweight (cwt.)
2000 pounds = 1 ton (T.)

Exercises

1. Lillian asks the grocer for $\frac{3}{4}$ lb. of butter. How many ounces of butter should he give her?

2. In his father's store Henry found packages of groceries with these weights: 2 oz., 4 oz., 6 oz., 8 oz., 12 oz., 15 oz., and $\frac{1}{2}$ oz. What part of a pound was each?

3. On a can of peaches Louise read: "Net weight, 28 oz." This meant that the peaches without the can weighed 28 oz. Look at packages of crackers, breakfast cereals, and canned goods and see if you can find the net weight marked on each package.

4. Mary can buy a 4-ounce jar of nuts for 36¢ or a 6-ounce jar for 48¢. How much does she save on each ounce if she buys the larger jar?

WEIGHING HEAVY THINGS

1. At \$13.80 a ton, find the cost of 4 T. of coal; of $3\frac{1}{4}$ T.; of $6\frac{1}{2}$ T.; of 5 cwt.

2. A coal truck can carry 4500 lb. How many tons of coal can the truck carry at one time?

3. Mr. Cox delivers furnaces in a 2-ton truck, which is a truck that can carry a load of 2 tons. If each furnace weighs 1600 lb., can the truck carry 2 furnaces at a time? 3 furnaces at a time?

4. It costs \$1.32 per hundredweight to ship books by freight to a certain town. How much will it cost to ship books weighing 200 lb.? 150 lb.? 175 lb.?

5. Five rowboats, each weighing 160 lb., are shipped from Philadelphia to the Rangeley Lakes, Maine. What are the freight charges if the freight rate is \$1.50 per 100 lb.?

6. Coal at the mine, iron ore, and scrap iron are sometimes sold by the *long ton*. A long ton equals 2240 lb. Mr. Edwards, the coal dealer, buys 100 long tons of coal. How many regular tons will that make?

7. David weighs $94\frac{1}{4}$ lb. He should weigh 98 lb. How many pounds underweight is he?

Tell what numbers should be put in place of the dots:

8. $\frac{1}{4}$ T. = . . . lb.

9. $\frac{3}{8}$ lb. = . . . oz.

10. $2\frac{3}{4}$ lb. = . . . oz.

11. 12 oz. = . . . lb.

12. 600 lb. = . . . cwt.

13. 18 T. = . . . lb.

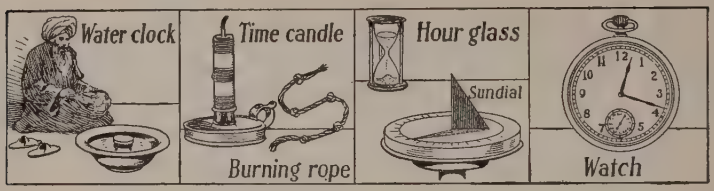
14. 25 lb. = . . . cwt

15. 7000 lb. = . . . T.

16. 1 lb. 10 oz. = . . . oz.

17. 3 lb. 4 oz. = . . . oz.

UNITS FOR MEASURING TIME



1. Memorize this table of *time:*

60 seconds (sec.)	= 1 minute (min.)
60 minutes	= 1 hour (hr.)
24 hours	= 1 day (da.)
7 days	= 1 week (wk.)
12 months (mo.) or 365 days	= 1 year (yr.)
366 days	= 1 leap year
100 years	= 1 century

2. Leap years come every 4 years and are divisible by 4. Thus, 1928, 1932, and 1936 are leap years; but century years, such as 1900 and 2000, are leap years only when divisible by 400. Thus, 2000 is a leap year, but 1900 is not.

3. Memorize this rime:

Thirty days have September,
April, June, and November;
All the rest have thirty-one,
Except the second month alone,
To which we twenty-eight assign,
Till leap year gives it twenty-nine.

4. Find out what you can about the ways of measuring time shown at the top of this page.

PROBLEMS ABOUT TIME

1. Dick is waiting for a train that is due at 4.50 P.M. He finds that it will be 35 min. late. At what time will the train arrive?

2. Edward was 11 yr. old on Apr. 5 of this year, while Doris was 11 yr. old on July 2. How many days older is Edward than Doris?

3. Dorothy goes to sleep at 7.30 P.M. and gets up at 6.30 A.M. How many hours of sleep does she get?

4. John was a messenger boy at a store during the summer. Each morning he worked from 9.00 A.M. to 12.15 P.M. After $\frac{3}{4}$ hr. for lunch, he worked again until 5.00 P.M. How many hours a day did he work?

5. Dora read that an old church was built two and a quarter centuries ago. How many years ago was that?

6. Sam read that a baby is born somewhere in the United States every 12 sec. If this is true, how many babies are born here in a year of 365 da.?

7. If you want to take the faster train from Boston to New York, which of these should you take?

TRAIN	No. 52	No. 23
Leaves Boston	11.00 A.M.	4.00 P.M.
Arrives New York	5.07 P.M.	9.10 P.M.

Tell what numbers should be put in place of the dots:

8. 7 wk. = . . . da.

9. $2\frac{1}{4}$ da. = . . . hr.

10. $1\frac{1}{2}$ yr. = . . . mo.

11. $1\frac{1}{4}$ hr. = . . . min.

12. $1\frac{1}{2}$ min. = . . . sec.

13. 8 hr. = . . . da.

14. 6 mo. = . . . yr.

15. 10 da. = . . . wk.

16. 30 sec. = . . . min.

17. 90 min. = . . . hr.

COUNTING ARTICLES

Memorize this table for *counting articles:*

12 units	= 1 dozen (doz.)
12 dozen or 144 units	= 1 gross
20 units	= 1 score

Memorize this table for *counting paper:*

24 sheets or 25 sheets	= 1 quire
20 quires	= 1 ream

When paper is folded, 24 sheets make 1 quire and 480 sheets make 1 ream. When paper is not folded, 25 sheets make 1 quire and 500 sheets make 1 ream. If you buy 1 ream of typewriter paper, you get 500 sheets of paper.

Exercises

1. Mr. Fox is 3 score and 10 years old. How old is he?

2. How many lemons are $3\frac{1}{4}$ doz.? $1\frac{3}{4}$ doz.? $2\frac{1}{2}$ doz.?

3. Our school bookstore buys pencils by the gross. How many pencils are there in 7 gross? in $\frac{1}{2}$ gross?

4. Mr. Roe buys golf balls at \$72.00 a gross and sells them for \$.85 each. Find his profit on each ball.

5. Mr. Law bought baseballs at \$6.60 a dozen and sold them at \$.75 each. Find his profit on a dozen balls.

6. Jack had his picture taken at the Dorset Studios. His mother bought $1\frac{1}{4}$ doz. photographs at \$6.00 a dozen. How much did she pay for them? How much did each photograph cost?

7. Edward buys $\frac{1}{2}$ ream of typewriter paper. How many sheets of paper should he get?

IMPROVEMENT TEST NO. 10

Test 10 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.	6.
62	68	27	77	38	86
95	47	60	26	71	23
81	46	41	55	66	24
69	94	96	45	20	75
13	73	21	10	30	73
84	72	98	89	97	80
73	29	72	42	46	16
44	30	43	58	90	10
56	95	38	37	47	39
95	78	25	29	63	13
46	22	89	13	40	94

Test 10 B — Multiplication (Time 4 min. after copying)

1.	2.	3.	4.
9074	5264	5830	5760
346	309	528	916

Test 10 C — Multiplication (Time 5 min. after copying)

1.	2.	3.
24679	75918	90764
835	296	487

Test 10 D — Division (Time 4 min. after copying)

1. $67\overline{)49848}$ 2. $48\overline{)40297}$ 3. $23\overline{)11362}$

4. $21\overline{)16926}$ 5. $77\overline{)44671}$

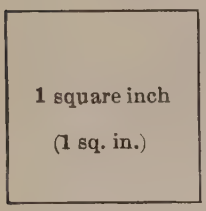
Test 10 E — Division (Time 5 min. after copying)

1. $456\overline{)232104}$ 2. $227\overline{)140286}$ 3. $674\overline{)209716}$

AREA OF A RECTANGLE

1. This figure is a **rectangle.** Doors, windows, and sheets of paper usually have the shapes of rectangles. Notice that the opposite sides of the rectangle are of the same length. The corners of a rectangle look like this ⌊ ⌉ ⌋ and are called *square corners* or *right angles.* Point out rectangles in your classroom.

2. A **square** has all its sides equal and all its corners are right angles. Each side of this square is 1 in. long; its **area** is 1 square inch. A square having each side 1 ft. long has an area of 1 sq. ft. What is the area of a square having each side 1 yd. long? 1 mi. long?



3. The figure at the left represents a rectangle 5 ft. long and 3 ft. wide. To find its area, you must find how many square feet it contains. It has 3 rows with 5 sq. ft. in each row; hence its area is 3×5 sq. ft., or 15 sq. ft.

To find the area of a rectangle, multiply its length by its width.

4. A rectangle 5 in. long and 2 in. wide is said to measure 5 in. by 2 in., which is often written 5 in. $\times$ 2 in.

5 in. may be written 5″ and 7 ft. may be written 7′.

Find the areas of these rectangles:

5. 6 ft. by 3 ft.
6. 9 ft. by 4 ft.
7. 7 ft. by 4 ft.
8. 10 ft. $\times$ 8 ft.
9. 36 ft. $\times$ 9 ft.
10. 17 ft. $\times$ 12 ft.
11. $8' \times 4'$
12. $7'' \times 7''$
13. $12'' \times 12''$

FINDING AREAS OF RECTANGLES

1. Mr. Carr's lawn is 38 ft. by 26 ft. How much will it cost to sod the lawn at 8¢ a square foot?

2. Fred may have a garden 40 ft. square or one 24 ft. by 52 ft. If he takes the larger garden, which does he take?

3. At $2 a square yard, find the cost of making a cement walk 1 yd. wide and 24 yd. long.

For which of these should you find the areas in square inches? in square feet? in square yards?

4. The blackboard

5. A small blotter

6. The cover of a book

7. A gymnasium floor

Find the area of each of these rectangles:

8. 6 yd. × 5 yd.

9. 9 yd. × 8 yd.

10. 36′ × 17′

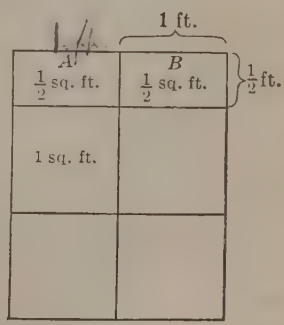
11. 18″ × 12″

12. 38 in. × 1 in.

13. 175 yd. × 1 yd.

Using Fractions in Areas

1. This figure represents a rectangle $2\frac{1}{2}$ ft. long and 2 ft. wide. A and B together make 1 sq. ft., and the whole area is 5 sq. ft.



You can also get the area by finding that $2\frac{1}{2} \times 2 = 5$. Hence the rule for finding the area of a rectangle holds also if either dimension contains a fraction.

Find the area of each of these rectangles:

2. 4 ft. × $5\frac{1}{2}$ ft.

3. 4 in. × $6\frac{1}{4}$ in.

4. 7 yd. × $6\frac{1}{4}$ yd.

5. $3\frac{1}{4}$ ft. × $5\frac{1}{2}$ ft.

6. $6\frac{1}{2}$ yd. × $3\frac{3}{4}$ yd.

7. $2\frac{1}{2}$ rd. × $7\frac{1}{8}$ rd.

8. 8′ × $3\frac{1}{2}$′

9. 12″ × $6\frac{3}{4}$″

10. $2\frac{1}{2}$″ × $2\frac{1}{2}$″

EXPRESSING DIMENSIONS IN THE SAME UNIT

In using the rule for the area of a rectangle, be sure that the length and the width are *both* expressed in inches, *both* in feet, or *both* in yards, etc. If a rectangle is 1 ft. long and 4 in. wide, first change 1 ft. to 12 in. Then the area is 4×12 sq. in., or 48 sq. in.

Find the areas of these rectangles:

1. 1 ft. 3 in. $\times$ 6 in.
2. 2 ft. 6 in. $\times$ 3 in.
3. 1 yd. 2 ft. $\times 1\frac{1}{2}$ ft.
4. $\frac{3}{4}$ ft. $\times 4\frac{1}{4}$ in.
5. $1\frac{1}{2}$ yd. $\times$ 2 ft.
6. $1\frac{3}{4}$ ft. $\times$ 7 in.

7. Bert's garden is 48 ft. 3 in. by 30 ft. 6 in. Susan's is 36 ft. 6 in. by 34 ft. 3 in. Find the area of each garden in square feet. Whose garden is larger?

Since the areas are large, change 48 ft. 3 in. to $48\frac{1}{4}$ ft., etc.

SQUARE MEASURE

1. Draw a square foot on the board. Show that 1 sq. ft. $= 12 \times 12$ sq. in., or 144 sq. in.

2. Draw a square yard on the board. How many *feet* long is it? how many *feet* wide? Show that 1 sq. yd. contains 3×3 sq. ft., or 9 sq. ft.

3. On the school ground mark off a rectangle 16 rd. by 10 rd. This rectangle contains 160 sq. rd. or 1 *acre*.

4. Memorize this table of *square measure:*

144 square inches (sq. in.)	=	1 square foot (sq. ft.)
9 square feet	=	1 square yard (sq. yd.)
$30\frac{1}{4}$ square yards	=	1 square rod (sq. rd.)
160 sq. rd. or 43,560 sq. ft.	=	1 acre (A.)
640 acres	=	1 square mile (sq. mi.)

FARMS AND GARDENS

1. Matthew's garden has an area of 15 sq. yd. How many square feet is that?

2. Lola's garden is 12 ft. square. What is its area in square feet? in square yards?

3. Show that a farm of 1 acre contains 43,560 sq. ft.

Change 160 sq. rd. to square yards and then change the square yards to square feet.

4. How many acres are there in a farm 80 rd. by 110 rd.? in a field 80 rd. by 50 rd.?

5. Our school garden is square and measures 209 ft. on each side. Is its area more or less than an acre?

6. If a school garden is 208 ft. on each side, is its area more or less than an acre?

7. Uncle Joe owned a field 60 rd. long and 28 rd. wide. He sold it to a neighbor at \$75 an acre. How much did he receive for it?

8. On his farm Mr. Jones made a concrete walk $2\frac{1}{2}$ ft. wide and 90 ft. long. Find the cost at \$2.30 a square yard.

9. The farms of Rhode Island contain 483 sq. mi., while those of Texas contain 171,560 sq. mi. Mr. Dow says that Texas has over 355 times as much land in farms as Rhode Island. Is he right?

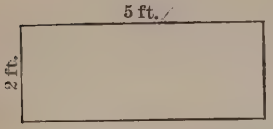
10. How many square rods are there in $2\frac{1}{2}$ A.?

11. How many acres are there in 640 sq. rd.? in 40 sq. rd.? in 4356 sq. ft.?

12. How many square feet are there in 8 sq. yd.? in $3\frac{1}{2}$ sq. yd.? in $\frac{1}{4}$ A.? in 288 sq. in.?

DRAWING JACK'S WORKBENCH

The top of Jack's workbench is 5 ft. by 2 ft. Jack makes a drawing of the top of the bench, letting $\frac{1}{4}$ in. stand for 1 ft.



If $\frac{1}{4}$ in. stands for 1 ft., how many inches stand for 4 ft.? for 5 ft.? for 2 ft.? Measure Jack's drawing with your ruler and see if it is right.

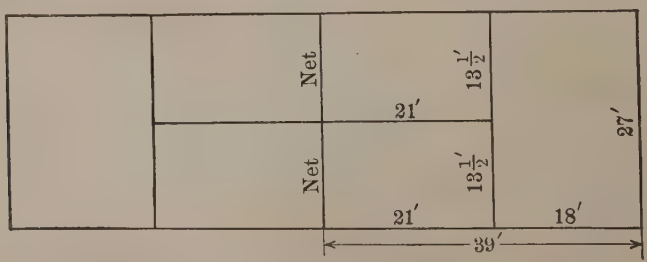
This is a **scale drawing** and it is made *to the scale of* $\frac{1}{4}$ *in. to* 1 *ft.* The scale may be written $\frac{1}{4}'' = 1'$.

MAKING SCALE DRAWINGS

1. A swimming tank is 100 ft. by 50 ft. Draw a plan of it to the scale of 1 in. = 10 ft. On this plan, how many inches represent 20 ft.? 50 ft.? 25 ft.?

2. A baseball diamond is 90 ft. square. Draw a plan of it, letting $\frac{1}{2}$ in. = 10 ft.

3. Draw this tennis court, letting $\frac{1}{8}$ in. = 1 ft. How many inches represent 8 ft.? 18 ft.? 21 ft.? 27 ft.? $\frac{1}{2}$ ft.? $13\frac{1}{2}$ ft.?

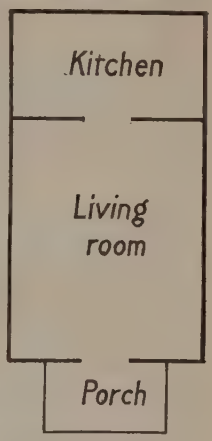


Draw these rectangles to the scale of $\frac{1}{8}$ *in.* = 1 *ft.:*

4. 16 ft.×8 ft.	**7.** 17′×10′	**10.** 20′×22½′
5. 24 ft.×12 ft.	**8.** 24′×21′	**11.** 40′×37½′
6. 20 ft.×10 ft.	**9.** 32′×28′	**12.** 19′×19′

THE PLAN OF A BUNGALOW

1. Tom drew this plan of his bungalow in the woods, letting $\frac{1}{16}$ in. = 1 ft. How many feet does $\frac{1}{8}$ in. represent? $\frac{1}{4}$ in.? $\frac{5}{16}$ in.? $\frac{1}{2}$ in.? $\frac{3}{4}$ in.? 1 in.?



SCALE: $\frac{1}{16}$ in. = 1 ft.

2. Measure the length and the width of the living room on Tom's drawing. If $\frac{1}{16}$ in. = 1 ft., how many feet long is the living room? how many feet wide?

3. How many feet long is the kitchen? how many feet wide? How long and how wide is the porch?

4. Draw a plan of a bungalow, letting $\frac{1}{8}$ in. = 1 ft. Tell how many feet long and how wide each room is.

Other Problems

1. A cement walk 35 ft. long is represented in a drawing by a length of 7 in. What scale has been used?

2. A school baseball field is 490 ft. by 350 ft. Harry's plan of the field is 7 in. by 5 in. What scale has he used?

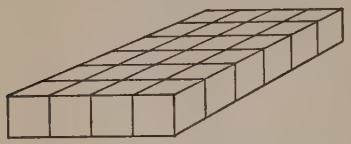
3. On a map on which 1 in. = 250 mi., two cities are $2\frac{1}{2}$ in. apart. What is the distance between them?

4. On a map drawn to the scale of 114 mi. to 1 in., Jackson, Miss., is $3\frac{1}{4}$ in. from Atlanta, Ga. How many miles is it from Jackson to Atlanta?

5. Find the scales of ten maps in your geography.

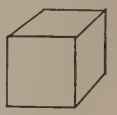
HOW TO FIND THE VOLUME OF A BOX

1. Eva poured some fudge into a pan to cool. The pan was 4 in. wide and 6 in. long. She cut the fudge into 1-inch squares. When she took it out of the pan she found that it was 1 in. thick and looked as shown here.



Each piece of fudge is 1 in. high, 1 in. wide, and 1 in. long. Each piece is an **inch cube** containing 1 *cubic inch*. Its **volume** is 1 cubic inch (1 cu. in.).

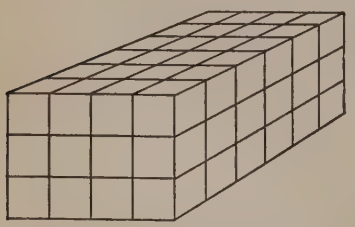
2. How many cubic inches of fudge did Eva have? Since the fudge was 4 in. wide, 6 in. long, and 1 in. high, she got 4×6 cu. in., or 24 cu. in.



1 cu. in.

3. Eva has a box 4 in. wide, 6 in. long, and 3 in. high. Will one pan of fudge cover the bottom of the box?

4. Dan says that since the box is 3 in. high, it will hold 3 pans of fudge, which makes 3×24 cu. in., or 72 cu. in., of fudge. Is he right? The picture shows the 72 cu. in. of fudge.



5. If a box holds 72 cu. in., its **volume** is 72 cu. in. A quick way to find the volume of Eva's box is to multiply its length, its width, and its height, thus:

$3 \times 4 \times 6 = 72$, the number of cubic inches

To find the volume of a box, multiply together the length, the width, and the height.

FINDING VOLUMES

1. Bertha has two candy boxes. One is 6 in. by 4 in. by 2 in. and the other is 6 in. by 3 in. by 3 in. Which box will hold more candy? how many cubic inches more?

2. Joan is sending a box of fruit to her city cousin. Which box will hold the most fruit: one that is 16 in. by 16 in. by 9 in., one that is 18 in. by 14 in. by 10 in., or one that is 15 in. by 15 in. by 12 in.?

3. A schoolroom should have 200 cu. ft. of air space for each pupil. How many cubic feet of air space has a room 35 ft.$\times$30 ft.$\times$12 ft.? This is enough for how many pupils?

4. Find the volume of a block of marble $14' \times 2' \times 1\frac{1}{2}'$; of a block of granite $6\frac{1}{2}'$ square and $8'$ high.

5. How many cubic feet of water will fill a pool 50 ft. long and 28 ft. wide to a depth of $5\frac{1}{2}$ ft.?

6. How many cubic feet of water will it take to flood a skating rink 96 ft. by 125 ft. to a depth of 2 in.? How much will the water cost at \$2.75 per 1000 cu. ft.?

Change 2 in. to $\frac{1}{6}$ ft., since all dimensions must be in the same unit.

First express all dimensions in the same unit; then find the volumes of these solids:

7. $7' \times 4' \times 4'$

8. $6' \times 3' \times 2''$

9. $5'' \times 3'' \times 2''$

10. $9'' \times 6'' \times 5''$

11. $3\frac{1}{2}' \times 2' \times 2'$

12. $8'' \times 4\frac{1}{2}'' \times 2\frac{3}{4}''$

13. $35' \times 30' \times 12\frac{1}{2}'$

14. 8 ft.$\times$7 ft.$\times$6 in.

15. 6 ft.$\times$6 ft.$\times 3\frac{1}{2}$ ft.

16. 2 yd.$\times$1 yd.$\times$1 yd.

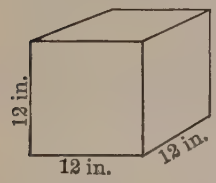
17. 4 yd.$\times$2 yd.$\times$1 yd.

18. 16 ft.$\times 12\frac{1}{2}$ ft.$\times$8 in.

19. $4\frac{1}{2}$ ft.$\times$12 ft.$\times$10 in.

20. 9 ft.$\times$8 ft.$\times$7 ft. 6 in.

TABLE OF CUBIC MEASURE



1 cu. ft.

1. A cubic foot is 12 in. long, 12 in. wide, and 12 in. high. Show that 1 cu. ft. contains 1728 cu. in.

2. A cubic yard is 3 ft. long, 3 ft. wide, and 3 ft. high. Show that 1 cu. yd. contains 27 cu. ft.

3. Memorize this table of *cubic measure:*

1728 cubic inches (cu. in.) = 1 cubic foot (cu. ft.)
27 cubic feet = 1 cubic yard (cu. yd.)

Exercises

1. An aquarium is 12 in. by 18 in. at the bottom and 11 in. high. If it is filled to within 2 in. of the top, does it contain more or less than 1 cu. ft. of water?

2. In excavating a cellar 24 ft. by 28 ft. by 5 ft., how many cubic yards of earth are removed? Find the cost of digging the cellar at 70¢ a cubic yard.

3. How many truck loads of earth are removed in digging a ditch $1\frac{1}{2}$ ft. wide, $1\frac{3}{4}$ ft. deep, and 432 ft. long, if 5 cu. yd. make a load for a truck?

4. How many books, each 8 in. long, 6 in. wide, and 1 in. thick, could be packed in a box measuring 3 ft. $\times$ 2 ft. $\times 1\frac{1}{2}$ ft. on the inside?

Tell what number should be put in place of the dots:

5. $1\frac{1}{2}$ cu. ft. = . . . cu. in.
6. $4\frac{1}{2}$ cu. yd. = . . . cu. ft.
7. 18 cu. ft. = . . . cu. yd.
8. 162 cu. ft. = . . . cu. in.
9. 162 cu. ft. = . . . cu. yd.
10. 3456 cu. in. = . . . cu. ft.

IMPROVEMENT TEST NO. 11

Test 11 A — Subtraction (Time 4 min.)

1. $5\frac{5}{16}$ − $3\frac{1}{4}$
2. $9\frac{3}{4}$ − $8\frac{1}{8}$
3. $7\frac{1}{4}$ − $2\frac{1}{2}$
4. 8 − $6\frac{9}{10}$
5. $6\frac{2}{3}$ − $2\frac{1}{4}$
6. $9\frac{1}{3}$ − $5\frac{1}{2}$
7. $4\frac{5}{6}$ − $2\frac{1}{6}$
8. 7 − $6\frac{5}{8}$
9. $2\frac{1}{2}$ − $\frac{3}{5}$
10. $6\frac{11}{12}$ − $4\frac{5}{12}$
11. $8\frac{1}{12}$ − $5\frac{1}{2}$
12. $9\frac{7}{16}$ − $4\frac{3}{16}$

Test 11 B — Multiplication (Time 4 min. after copying)

1. $\$1.12\frac{1}{2} \times 7$
2. $\$1.16 \times 3\frac{3}{4}$
3. $\$1.68 \times 29\frac{5}{8}$
4. $\frac{2}{3}$ of $\frac{9}{16}$
5. $\frac{5}{6} \times 1\frac{1}{5}$
6. $2\frac{2}{5} \times 5\frac{5}{6}$
7. $\frac{1}{12}$ of 27
8. $27 \times 2\frac{5}{6}$
9. $8\frac{1}{3} \times 2\frac{1}{10}$

Test 11 C — Division (Time 4 min. after copying)

1. $\frac{5}{8} \div \frac{3}{4}$
2. $15 \div \frac{1}{2}$
3. $2\frac{2}{5} \div \frac{2}{3}$
4. $\frac{3}{10} \div \frac{3}{5}$
5. $1\frac{7}{8} \div 6$
6. $7\frac{1}{2} \div \frac{9}{10}$
7. $\frac{7}{16} \div \frac{5}{12}$
8. $5\frac{1}{4} \div 7$
9. $4\frac{1}{2} \div 3\frac{3}{4}$

DECIMALS

A New Way to Write Tenths and Hundredths

In everyday life, fractions like $\frac{3}{10}$, $\frac{26}{100}$, and $\frac{23}{1000}$ are often used. If Tom has a fever, his temperature may be $101\frac{3}{10}$ degrees; the weather report after a storm will tell that $\frac{26}{100}$ of an inch of rain fell; a camera may take a picture in $\frac{1}{1000}$ of a second; and a machinist may find that a very thin sheet of metal is $\frac{23}{1000}$ of an inch thick. All these fractions, which have denominators of 10, 100, or 1000, are used so often that it is convenient to have a short way of writing them.

We sometimes write 5¢ as \$.05 and 23¢ as \$.23. Since there are 100 cents in a dollar, \$.05 is $\frac{5}{100}$ of a dollar and \$.23 is $\frac{23}{100}$ of a dollar.

\$.05 is a short way of writing $\$\frac{5}{100}$

\$.23 is a short way of writing $\$\frac{23}{100}$

Similarly,

.05 lb. is a short way of writing $\frac{5}{100}$ lb.

and .23 ft. is a short way of writing $\frac{23}{100}$ ft.

We can also write 10ths and 1000ths this short way:

.3 lb. is a short way of writing $\frac{3}{10}$ lb.

.135 ft. is a short way of writing $\frac{135}{1000}$ ft.

.001 sec. is a short way of writing $\frac{1}{1000}$ sec.

While $\frac{3}{10}$, $\frac{5}{100}$, and $\frac{135}{1000}$ are called **common fractions,** .3, .05, and .135 are called **decimal fractions** or **decimals.** The periods in front of .3, .05, and .135 are called **decimal points.** You see that the decimal point makes it possible to write $\frac{3}{10}$ or $\frac{5}{100}$ *without writing the denominator;* hence in writing a decimal you must always be sure to use the decimal point.

READING AND WRITING DECIMALS

Every common fraction has the same name as its denominator. Thus, $\frac{2}{3}$ is called 2 *thirds* because the denominator is 3. In the same way, every decimal fraction has the same name as its *understood* denominator. Thus, .7 is called 7 *tenths* because the understood denominator is 10; .23 is called 23 *hundredths* because the understood denominator is 100; and .017 is called 17 *thousandths* because the understood denominator is 1000.

The number of zeros in the understood denominator is always the same as the number of places in the decimal. Thus, .016 has 3 places, hence its understood denominator has 3 zeros and must be 1000. That is, $.016 = \frac{16}{1000}$.

Sometimes .3 is written 0.3, the zero being put before the decimal point to make sure that the decimal point is not overlooked.

Exercises

Read the following:

1.	.5 ft.	.75 lb.	.7	.8	.10	0.03
2.	.25 in.	.08 ft.	.09	.25	.250	0.009
3.	.05 mi.	.125 sec.	.006	.075	.207	0.019

Write each of the following as a decimal:

4.	$\frac{1}{10}$	$\frac{23}{100}$	$\frac{109}{1000}$	$\frac{25}{1000}$	$\frac{65}{100}$	$\frac{350}{1000}$
5.	$\frac{8}{10}$	$\frac{7}{100}$	$\frac{2}{1000}$	$\frac{40}{1000}$	$\frac{40}{100}$	$\frac{17}{1000}$

Write each of the following as a common fraction:

6.	.7	.26	.08	.024	.007	.800
7.	.1	.60	.11	.125	.010	.005

READING AND WRITING DECIMALS

A number like 5.023, which consists of a whole number and a decimal, is a **mixed decimal,** just as $5\frac{23}{1000}$ is a mixed number. The number 5.023 is read as "5 *and* 23 thousandths," the decimal point being read " and." In business 5.023 is often read " five-point-o-two-three."

In a whole number, each place has a name. In 426, for example, 6 is in the *units'* place, 2 is in the *tens'* place, and 4 is in the *hundreds'* place. In the same way, each place in a decimal has a name. The first place to the right of the decimal point is *tenths*, the second place is *hundredths*, and the third place is *thousandths*.

Thousands	Hundreds	Tens	Units	Decimal point (read "and")	Tenths	Hundredths	Thousandths
3	4	0	6	.	8	4	7
WHOLE NUMBERS					DECIMALS		

The above number is read "three thousand four hundred six *and* eight hundred forty-seven thousandths."

Exercises

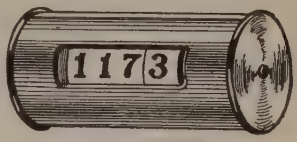
1. Read: 6.7 3.12 3.1 2.03 4.016 2.117
2. Write as mixed decimals: $7\frac{5}{10}$ $12\frac{6}{100}$ $8\frac{25}{100}$ $6\frac{15}{1000}$

Write the following numbers:

3. One hundred eighteen and fourteen hundredths.
4. Four hundred thirty-six thousandths.
5. Six hundred and sixty-six thousandths.
6. One-three-five-point-seven-two.
7. One-nine-six-o-point-o-one-seven.

MEASURING HOW FAR YOU RIDE

Fred's bicycle has a cyclometer, which tells how far he rides. After he has ridden 117.3 miles, the cyclometer reads as shown here. The right-hand figure stands for *tenths* of a mile and the other figures stand for whole miles. A line is here used in place of the decimal point to separate the decimals and the whole numbers.



Each time that Fred rides .1 mile, the right-hand figure becomes 1 larger. The cyclometer now reads | 117 | 3 |. After Fred rides another .1 mile, it will read | 117 | 4 |.

The speedometer on Mr. Hill's car tells how many miles he drives. Read a speedometer just as you read a cyclometer. This speedometer shows that Mr. Hill has driven 1423.7 mi.

On cyclometers and speedometers, the right-hand figure, which indicates tenths of a mile, is usually printed in red, while the other figures are in black.

Exercises

Tell how many miles each speedometer registers:

1. | 2060 | 2 | **2.** | 1103 | 0 | **3.** | 9174 | 5 | **4.** | 6123 | 9 |

Tell how many miles each cyclometer registers:

5. | 107 | 2 | **6.** | 124 | 6 | **7.** | 200 | 0 | **8.** | 120 | 5 |

9. How will Fred's cyclometer read after he has ridden another .1 mile, if it now reads 117.9? if it reads 199.9?

HOW TO ADD DECIMALS

1. John bought a coat for \$7.50, a tie for \$.75, and a straw hat for \$1.25. How much did he spend in all?

To add dollars and cents, write the numbers with the decimal points directly under one another and place a decimal point in the answer under the other decimal points. When you add dollars and cents you are really adding decimals.

\$7.50
.75
1.25
\$9.50

John spent \$9.50 in all.

2. Peter rode his bicycle 7.3 mi. on Monday, 12.8 mi. on Tuesday, and 9.4 mi. on Wednesday. How far did he ride in all in these three days?

Add other decimals just as you add dollars and cents. Place the decimal point in the answer directly under all the other decimal points.

7.3
12.8
9.4
29.5

Peter rode his bicycle 29.5 mi. in the three days.

3. Bill paid \$2 for a bat, \$1.25 for a fielder's glove, and \$1.05 for a baseball cap. How much did he pay in all?

You can add as shown in *A* if you keep the decimal points in a straight line. It is better, however, first to write \$2 as \$2.00, as shown in *B*, because it is easier to keep the figures in the correct columns if each number has the same number of decimal places.

A	*B*
\$2.	\$2.00
1.25	1.25
1.05	1.05
\$4.30	\$4.30

You see that Bill paid \$4.30 in all. How do you check the work?

4. Elizabeth rode her bicycle 4 mi. on Thursday and 9.3 mi. on Saturday. How far did she ride both days?

You could add as shown in *C*; but it is safer first to write 4 as 4.0, as shown in *D*. Why?

Elizabeth rode 13.3 mi. in all.

C	*D*
4.	4.0
9.3	9.3
13.3	13.3

USING DECIMALS IN ADDITION

1. Last week Dick rode these distances on his bicycle: 17.4 mi., 19.5 mi., 8.6 mi., 7.4 mi., and 15 mi. How many miles did he ride in all?

2. Mr. Blake drove his car 58.6 mi. on Monday, 61.8 mi. on Tuesday, 43.9 mi. on Wednesday, 51.3 mi. on Thursday, 72.9 mi. on Friday, and 67.2 mi. on Saturday. How many miles did he drive in all?

3. Helen bought a school bag for \$1, a pencil case for \$.35, a pencil for \$.10, an eraser for \$.05, and a penholder for \$.12. How much did she pay for all?

Copy, and add. Check by adding the other way:

4.	8.5	**5.**	\$4.25	**6.**	\$6.09	**7.**	4.25	**8.**	4.378
	8.8		5.63		9.04		5.75		5.125
9.	9.4	**10.**	\$4.05	**11.**	\$4.07	**12.**	2.25	**13.**	4.375
	4.5		5.01		5.08		4.65		9.875
	5.4		7.05		9.06		5.25		.125
14.	4.7	**15.**	\$4.25	**16.**	\$2.	**17.**	7.37	**18.**	8.123
	9.3		3.		9.66		9.16		7.
	8.		7.75		8.35		3.		6.129
19.	8.1	**20.**	\$9.05	**21.**	\$8.25	**22.**	4.667	**23.**	9.008
	.5		4.17		4.83		4.625		4.334
	1.6		2.75		.75		.875		.624
	6.8		.86		8.29		5.125		.875
	.3		8.00		7.07		9.409		4.127
	3.9		7.27		.65		8.125		9.623
	9.8		2.50		6.25		1.375		7.164

TAKING TRIPS

1. Ella rode her bicycle 15.8 mi. on Monday and 17.1 mi. on Tuesday. How much farther did she ride on Tuesday than on Monday?

Subtract decimals just as you subtract dollars and cents, keeping the decimal points in a straight line under each other. Place the decimal point in the answer under the other decimal points.

$$\begin{array}{r} 17.1 \\ 15.8 \\ \hline 1.3 \end{array}$$

Ella rode 1.3 mi. farther on Tuesday than on Monday.

2. When Robert started on a bicycle trip, his cyclometer read 95.8 mi. When he returned, it read 113 mi. How far did he ride?

You could subtract as in *A*; but it is better to write 113 as 113.0, as shown in *B*, because it is easier to keep the figures in the correct columns if each number has the same number of decimal places.

A	*B*
113.	113.0
95.8	95.8
17.2	17.2

You find that Robert rode 17.2 miles.

3. The speedometer on Ned's car read 525.8 mi. before a trip and 675.3 mi. after it. How long was the trip?

4. On a vacation trip the speedometer on Mr. Allen's car read 1560 mi. when he left home and 3963.2 mi. when he returned. How far did he drive?

5. When Mr. Frost left home in his car, his speedometer read 1867.3 mi. When he stopped for lunch at a hotel, it read 1900.2 mi. When he reached Echo Lake, it read 1920.0 mi. How far was it from his home to the hotel? from the hotel to Echo Lake? from his home to the lake?

6. When Mr. Fay drove his car into the garage on Monday night his speedometer read 1937.4 mi. On Tuesday it read 1982.2 mi.; on Wednesday, 2003.0 mi. How far did he drive on Tuesday? on Wednesday?

SUBTRACTING AND ADDING DECIMALS

Subtract the following and check by adding:

1.	8.1 3.8	**8.**	7.05 1.67	**15.**	6.51 1.56	**22.**	9.166 .875	**29.**	9.323 6.365
2.	6.7 5.9	**9.**	3.25 .08	**16.**	4.25 1.12	**23.**	6.094 3.174	**30.**	7.125 5.004
3.	8.7 2.7	**10.**	4.21 2.25	**17.**	8.95 3.35	**24.**	9.122 7.254	**31.**	6.813 .136
4.	8.3 .8	**11.**	4.83 .17	**18.**	4.75 .83	**25.**	3.653 .950	**32.**	1.007 .666
5.	9.9 4.	**12.**	9.62 9.	**19.**	7.75 2.	**26.**	9.833 5.	**33.**	6.375 3.
6.	7.4 3.9	**13.**	7.34 .88	**20.**	8.45 5.69	**27.**	9.468 5.579	**34.**	9.242 1.749
7.	8. 3.5	**14.**	5. 1.33	**21.**	9. 3.75	**28.**	6. 1.251	**35.**	7. 2.005

Copy and subtract:

36. $6 - 4.3$ **39.** $4.25 - 3$ **42.** $22 - 18.5$

37. $8.7 - 6$ **40.** $1.25 - .65$ **43.** $37 - 9.75$

38. $6.7 - 5.9$ **41.** $8.18 - 4.29$ **44.** $16 - 7.333$

Copy these numbers in columns and add:

45. $4.25 + 8.75 + .83 + 9.25 + 1.75$

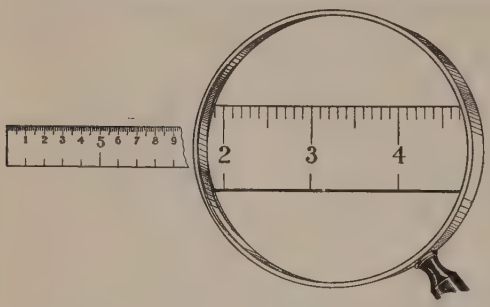
46. $5.125 + 3.625 + .125 + 7.667 + .333$

47. $19.5 + 4 + 3.8 + 5.9 + 6.7 + 10.$

MEASURING RAINFALL TO 100THS OF AN INCH

This morning Will put an empty pan outdoors. After a shower, the water in the pan was $\frac{1}{2}$ in. deep. Since $\frac{1}{2} = \frac{50}{100}$, or .50, therefore .50 in. of rain fell.

The Weather Bureau measures the amount of rain that falls to *hundredths* of an inch. On the upper edge of the ruler at the left, each of the very fine spaces is $\frac{1}{100}$ of an inch, while each of the larger spaces, marked 1, 2, 3, etc., is $\frac{1}{10}$ of an inch. The magnifying glass helps us to read the *hundredths* of an inch without straining our eyes.



Exercises

1. The daily Weather Report tells how much rain fell the day before in the prominent cities of the United States. The numbers show hundredths of an inch. In the report at the right, which city had the most rain? the least rain?

Try to find such a weather report in a newspaper.

Rainfall Yesterday

Buffalo	.10
Chicago	.48
Denver	.06
New York	.25
Pittsburgh	.10
Portland, Maine	.16
San Antonio	.48
Seattle	.28
Washington, D.C.	.88

2. How many hundredths of an inch make .1 in.? 1 in.? How many tenths of an inch make 1 in.?

MEASURING RAINFALL AND SNOWFALL

1. The Weather Bureau at Chicago reported this rainfall for the 12 months of a recent year: 0.92 in., 1.05 in., 3.05 in., 1.38 in., 3.46 in., 1.70 in., 2.67 in., 7.76 in., 2.50 in., 4.56 in., 1.46 in., 1.96 in. Find the total rainfall.

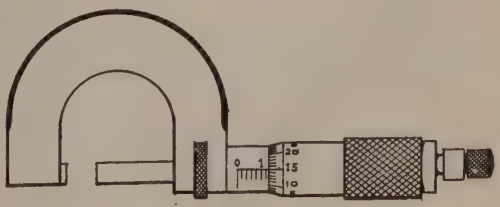
2. During a recent winter Omaha's snowfall was: December, 0.5 in.; January, 7.6 in.; February, 0.7 in.; and March, 28.8 in. Find the total snowfall for the winter.

3. In Yosemite, Calif., 7 in. of rain fell in April, while only 0.16 in. fell in August. How many more inches of rain fell in April than in August?

Other Uses for Decimals

1. To time a race, Charles used a stop watch that measures time to tenths of a second. Jane ran 75 yd. in 13.4 sec., while Anton did it in 11.8 sec. How much longer did Jane take than Anton?

2. In a machine shop Jack saw a man using a micrometer that makes measurements as fine as .001 of an inch. The thicknesses of four pieces of metal were found to be .234. in., .436 in., .240 in., and .025 in. Find their combined thickness in inches.



3. A surveyor measures land with a steel tape on which the foot is divided into tenths of a foot instead of into inches. If a rectangular lot is 106.0 ft. long and 38.5 ft. wide, what is the distance around the lot?

CHANGING A DECIMAL TO A COMMON FRACTION

Miss Daly tells Nell that the average weight of the girls in her class is 93.75 lb. She explains that .75 is a *decimal* equal to $\frac{75}{100}$, and that by dividing both terms of $\frac{75}{100}$ by 25, she gets $\frac{3}{4}$. Hence $\frac{75}{100} = \frac{3}{4}$, and 93.75 lb. is the same as $93\frac{3}{4}$ lb. When you have to change a decimal to a common fraction, you may use this rule:

To change a decimal to a common fraction, omit the decimal point and write the decimal over its understood denominator. Then reduce the fraction to lowest terms.

Thus, $.4 = \frac{4}{10} = \frac{2}{5}$; $.25 = \frac{25}{100} = \frac{1}{4}$

You can change decimals like $.12\frac{1}{2}$ and $.66\frac{2}{3}$ to common fractions in this way:

$$.12\tfrac{1}{2} = \frac{12\frac{1}{2}}{100} = \frac{12\frac{1}{2} \times 2}{100 \times 2} = \frac{25}{200} = \frac{1}{8} \qquad .66\tfrac{2}{3} = \frac{66\frac{2}{3}}{100} = \frac{66\frac{2}{3} \times 3}{100 \times 3} = \frac{200}{300} = \frac{2}{3}$$

Exercises

Change these decimals to common fractions:

1.	.5	.16	.375	.55	$.83\frac{1}{3}$
2.	.2	.30	.625	.50	$.62\frac{1}{2}$
3.	.6	.15	.875	$.16\frac{2}{3}$	$.37\frac{1}{2}$
4.	.1	.20	.250	$.33\frac{1}{3}$	$.87\frac{1}{2}$

5. Mr. Flynn's car goes 17.8 mi. on 1 gal. of gasoline. Write 17.8 mi. without using a decimal.

6. Memorize these fractional equivalents of decimals:

$.12\frac{1}{2} = \frac{1}{8}$	$.37\frac{1}{2} = \frac{3}{8}$	$.66\frac{2}{3} = \frac{2}{3}$
$.25 = \frac{1}{4}$	$.50 = \frac{1}{2}$	$.75 = \frac{3}{4}$
$.33\frac{1}{3} = \frac{1}{3}$	$.62\frac{1}{2} = \frac{5}{8}$	$.87\frac{1}{2} = \frac{7}{8}$

MULTIPLYING A DECIMAL BY A WHOLE NUMBER

1. Last summer Ray worked in Mr. Todd's garden for $1.25 a day. How much did he earn in 9 days?

When you multiply dollars and cents, you are multiplying decimals. Place the decimal point before the last two right-hand figures of the product to separate the dollars and cents, thus *pointing off* as many decimal places in the product, $11.25, as there are in the multiplicand.

$$\begin{array}{r} \$1.25 \\ 9 \\ \hline \$11.25 \end{array}$$

Ray earned $11.25 in 9 days.

2. If an airplane averages 93.15 mi. an hour, how many miles does it go in 5 hr.?

You multiply any decimal by a whole number just as you multiply dollars and cents, pointing off as many decimal places in the product as there are in the multiplicand. How many decimal places are there in 93.15? Then how many decimal places should be pointed off in the product?

$$\begin{array}{r} 93.15 \\ 5 \\ \hline 465.75 \end{array}$$

The airplane goes 465.75 mi. in 5 hr.

To multiply a decimal by a whole number, first multiply as with whole numbers. Then, beginning at the right, point off as many decimal places in the product as there are decimal places in the multiplicand.

3. In his father's shop Jack found 4 sheets of copper each .013 in. thick. How thick were all 4 sheets together?

Since .013 has 3 decimal places, you must point off 3 decimal places in the product. To do this, write a 0 before 52, which gives .052.

$$\begin{array}{r} .013 \\ 4 \\ \hline .052 \end{array}$$

The 4 sheets together were .052 in. thick.

4. Ida's mother drove her car 7 hr. one day at an average of 25.6 mi. an hour. How far did she drive that day?

5. In driving his car on a vacation trip, Mr. Appleton averaged 175.6 mi. a day for 6 da. How many miles did he drive in all?

GRADED EXERCISES

Multiply. Check by going over the work again:

1. 43.2 × 4	**7.** 4.79 × 5	**13.** 7.62 × 49	**19.** 4.38 × 47	**25.** 4.67 × 68
2. 2.13 × 3	**8.** 4.53 × 9	**14.** 31.8 × 18	**20.** 6.19 × 94	**26.** .015 × 4
3. 9.45 × 3	**9.** 23.6 × 5	**15.** .398 × 26	**21.** 25.9 × 18	**27.** .014 × 7
4. 18.5 × 5	**10.** .467 × 8	**16.** 4.375 × 4	**22.** 37.9 × 37	**28.** .015 × 6
5. 2.56 × 7	**11.** .312 × 2	**17.** 4.175 × 6	**23.** 7.18 × 79	**29.** .019 × 5
6. 23.6 × 6	**12.** .675 × 2	**18.** 8.167 × 3	**24.** 57.6 × 25	**30.** .028 × 3

Multiply as many of these as you can in 10 minutes:

31. 46×9.82	**40.** $7 \times .011$	**49.** $462 \times .214$
32. $58 \times .108$	**41.** $6 \times .013$	**50.** 913×7.36
33. 28×9.53	**42.** $3 \times .014$	**51.** 648×2.63
34. 17×52.6	**43.** $3 \times .025$	**52.** 938×26.5
35. 95×3.42	**44.** 11×7.801	**53.** 509×19.9
36. 87×142.9	**45.** 39×9.258	**54.** $268 \times .038$
37. 61×897.4	**46.** 95×80.04	**55.** $405 \times .057$
38. 57×723.9	**47.** 26×95.06	**56.** 54×7.065
39. 34×300.8	**48.** 83×70.49	**57.** 27×86.53

PROBLEMS THAT USE DECIMALS

1. Mrs. Fox drives her car about 23.7 mi. an hour. At this rate, how far will she drive in 4 hr.?

2. If an airplane averages 93.25 mi. an hour, how far will it go in 7 hr.?

3. If sound travels .214 mi. a second, how far will the sound of a whistle travel in 5 sec.?

4. Mr. Rice, who lives 14.5 mi. from his office, drives his car to business each day. If he makes the round trip 6 times a week, how many miles does he drive in a week?

5. Frank's father drives a motor bus between two towns that are 5.7 mi. apart. Last Monday he made 12 round trips. How many miles did he drive that day?

6. Mr. Clark's car averages 14.75 mi. on 1 gal. of gasoline. How far can he travel on 15 gal.?

7. In ex. 6, show that 14.75 mi. is the same as $14\frac{3}{4}$ mi. Then show that you get the same answer as you did in ex. 6 if you multiply $14\frac{3}{4}$ mi. by 15.

8. In a large apartment house each apartment rents at \$97.50 a month. What is the income in a month from 48 apartments in this house?

9. The fare on a railroad is \$.036 a mile. In traveling 145 mi., how much will Mrs. James pay for a ticket for herself and a half-rate ticket for her daughter Jane?

10. Mr. Fuller runs a dairy farm. Last week he sold 1547 qt. of milk to a creamery at \$.055 a quart. How much money did he collect?

11. A cubic foot of ice weighs 56.4 lb. Find the weight of a piece of ice 4 ft. $\times$ 2 ft. $\times \frac{1}{2}$ ft.

MULTIPLYING A DECIMAL BY A DECIMAL

1. If a sight-seeing boat on the St. Lawrence River travels 11.25 mi. an hour, how far does it go in 3.1 hr.?

In finding 3.1×11.25, Rose first multiplies as with whole numbers and gets 34875. To find where to put the decimal point in the product, she estimates the answer mentally by multiplying the 11 of 11.25 by the 3 of 3.1, which gives 33. Since the answer should be a little more than 33, she puts the decimal point after the 34 of the product, making 34.875.

	11.25
	3.1
	1 125
	33 75
	34.875

Vera finds the position of the decimal point in ex. 1 *without estimating the answer*. This is Vera's way: There are 2 decimal places in 11.25 and 1 decimal place in 3.1, which makes 3 decimal places in 11.25 and 3.1 together. Hence she points off 3 decimal places in 34875, beginning at the right, which gives 34.875 as the answer. Does this agree with Rose's answer?

To multiply decimals, first multiply as with whole numbers. Then, beginning at the right, point off as many decimal places in the product as there are decimal places in the multiplier and the multiplicand together.

2. Mr. Pearson can drive his car 17.5 mi. on 1 gal. of gasoline. How far can he drive on 8.5 gal.?

3. Water weighs 62.5 lb. per cubic foot. Find the weight of the water which fills a pail whose volume is 1.3 cu. ft.

4. The rule in ex. 1 may also be used for multiplying a decimal by a whole number, as in finding 7×1.265.

There are 3 decimal places in 1.265; but there are *not any*, or 0, decimal places in 7. Adding 3 and 0, you get 3. Hence there should be 3 decimal places in the answer.

1.265
7
8.855

This rule may be used instead of the rule on page 163.

5. The average monthly rainfall last year in Holly was 3.24 in. What was the rainfall for the year?

GRADED EXERCISES

Multiply. Check by going over the work again:

1. 2.1 × 1.3	**7.** .65 × 7.6	**13.** 8.15 × .9	**19.** 628 × .062	**25.** 9.7 × .09
2. .92 × 4.6	**8.** .43 × .4	**14.** 4.71 × .8	**20.** 268 × 093	**26.** 296 × .705
3. 8.3 × .18	**9.** 429 × 1.7	**15.** 3.74 × 2.6	**21.** 628 × .48	**27.** 937 × .716
4. .43 × 2.3	**10.** 726 × 5.8	**16.** 13.8 × .57	**22.** 11.7 × .07	**28.** 145 × .068
5. .23 × .9	**11.** 469 × .19	**17.** 9.54 × 3.5	**23.** 35.8 × .34	**29.** 587 × .005
6. 9.5 × .28	**12.** 617 × .29	**18.** 1.67 × 3.4	**24.** 52.7 × .47	**30.** 3.45 × 1.9

Multiply as many of these as you can in 8 minutes:

31. 2.6×7.1	**39.** $.6\times.5$	**47.** $.48\times728$
32. $8.4\times.49$	**40.** $.3\times.9$	**48.** 9.5×492
33. $5.8\times.03$	**41.** $.5\times.36$	**49.** 5.1×107
34. $.27\times584$	**42.** $.7\times.83$	**50.** 9.8×5.63
35. $.083\times97$	**43.** 4.7×8.4	**51.** 8.9×2.98
36. $.062\times82$	**44.** 9.4×3.7	**52.** $.036\times638$
37. $.057\times65$	**45.** 9.5×841	**53.** $.006\times942$
38. 2.01×38	**46.** 4.2×6.59	**54.** $.003\times579$

PROBLEMS

1. The cyclometer on Lucy's bicycle showed that she had ridden 6.8 mi. in 1 hr. If she continued at this rate, how far did she go in 3.5 hr.?

2. Jack made a trip of 6.5 hr. on a train that traveled 47.3 mi. an hour. How far did Jack go?

3. The speed of ocean liners is measured in knots instead of in miles. On one trip the steamship *Leviathan* made an average speed of 28.04 knots an hour. A knot is equal to 1.15 mi. What was the *Leviathan's* speed in miles per hour?

4. Mary bought $3\frac{1}{2}$ yd. of serge at \$1.24 a yard. How much did it cost? Fred said that instead of multiplying \$1.24 by $3\frac{1}{2}$, he could get the same answer by multiplying \$1.24 by 3.5. Was Fred right? Why?

5. An airplane averaged 124.4 mi. an hour. At this rate, how far did it fly in 2.75 hr.? Show that you get the same answer by multiplying 124.4 by $2\frac{3}{4}$.

6. A bushel of potatoes weighs 60 lb. If .78 of a potato is water, how many pounds of water are there in a bushel of potatoes?

7. John saw some workmen putting a large block of granite in place on a new building. The granite was 5 ft. $\times$ 4 ft. $\times$ 2 ft. The workmen said that it weighed over 3 tons. Granite is 2.70 times as heavy as water and a cubic foot of water weighs 62.42 lb. How much do 40 cu. ft. of water weigh? How much do 40 cu. ft. of granite weigh? Were the workmen right?

8. Multiply $1\frac{3}{4}$ by $2\frac{1}{2}$ as you did on page 99. Then multiply 1.75 by 2.5. Do you get the same answer both ways?

IMPROVEMENT TEST NO. 12

Test 12 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.
$2\frac{1}{16}$	$4\frac{7}{10}$	$6\frac{5}{6}$	$5\frac{1}{2}$	$7\frac{3}{4}$
$5\frac{1}{2}$	$3\frac{3}{5}$	$4\frac{5}{12}$	9	2
7	$9\frac{1}{2}$	$1\frac{1}{6}$	$4\frac{3}{4}$	$9\frac{1}{2}$
$6\frac{3}{4}$	$\frac{1}{2}$	$1\frac{1}{3}$	$6\frac{3}{8}$	$8\frac{2}{3}$

Test 12 B — Multiplication (Time 4 min. after copying)

1. $10 \times \frac{5}{6}$
2. $\frac{9}{10} \times \frac{8}{9}$
3. $4\frac{3}{4} \times 18$
4. $8\frac{5}{8} \times \frac{1}{3}$
5. $\frac{3}{4} \times \frac{4}{15}$
6. $6\frac{2}{3} \times \$1.35$
7. $25 \times 1\frac{4}{5}$
8. $\frac{3}{10} \times 4\frac{1}{6}$
9. $6\frac{1}{2} \times \$2.98$

Test 12 C — Division (Time 4 min. after copying)

1. $7 \div \frac{2}{5}$
2. $8 \div 1\frac{1}{15}$
3. $3\frac{1}{4} \div 3\frac{1}{4}$
4. $9 \div 1\frac{5}{16}$
5. $2\frac{1}{4} \div 15$
6. $6\frac{2}{3} \div 1\frac{7}{8}$
7. $\frac{3}{4} \div \frac{9}{10}$
8. $13\frac{1}{2} \div \frac{3}{8}$
9. $16\frac{1}{2} \div 1\frac{1}{8}$

PLACING THE DECIMAL POINT

In these multiplication examples, the decimal point has been omitted in the product. Tell where the decimal point belongs in each answer. Then read the result, like this: "Two-point-one."

1.	.7 3 21	**6.**	.41 .6 246	**11.**	6.95 8 5560	**16.**	8.25 4 3300
2.	.7 .9 63	**7.**	6.7 5.8 3886	**12.**	27.3 .18 4914	**17.**	.355 24 8520
3.	.8 .5 40	**8.**	3.45 5 1725	**13.**	.046 5 230	**18.**	91.7 .28 25676
4.	48 .15 720	**9.**	1.25 1.3 1625	**14.**	.225 3 675	**19.**	825 .058 47850
5.	.57 9 513	**10.**	.051 2 102	**15.**	1.86 5.4 10044	**20.**	539 .028 15092

Tell where the decimal point belongs in each product:

21. $18 \times .66 = 1188$

22. $12 \times .087 = 1044$

23. $16 \times .018 = 288$

24. $13 \times .027 = 351$

25. $14 \times .213 = 2982$

26. $.09 \times 9.3 = 837$

27. $.46 \times 85.5 = 39330$

28. $4.8 \times 53.9 = 25872$

29. $9.7 \times 2.48 = 24056$

30. $1.65 \times 2.39 = 39435$

HOW TO DIVIDE A DECIMAL BY A WHOLE NUMBER

1. A boys' club paid \$9.20 for 8 baseballs. How much did each ball cost?

$$8)\$9.20$$
$$\$1.15$$

When you divide dollars and cents, you are dividing decimals. You have learned that you place the decimal point in the result directly below the decimal point in the dividend.

2. In Minneapolis, 24.36 in. of rain fell during one year. Find the average monthly rainfall.

Divide the decimal 24.36 just as you divide dollars and cents, placing the decimal point in the result above the decimal point in the dividend.

You find that the average monthly rainfall was 2.03 in.

To check, multiply 2.03 by 12, which gives 24.36. Hence the work is right.

Work	*Check*
2.03	2.03
12)24.36	12
24	4 06
36	20 3
36	24.36

In dividing a decimal by a whole number, place the decimal point in the quotient directly over the decimal point in the dividend. The quotient then has the same number of decimal places as the dividend.

Problems

1. It took a train 4 hr. to go a distance of 201.6 mi. How many miles per hour did the train travel?

2. Five girls earned \$84.75 in picking berries. What was the average amount earned per girl?

3. The speedometer on an automobile read 254.7 mi. before and 299.1 mi. after a 3-hour ride. What was the average number of miles traveled per hour?

4. An ocean steamship travels 436.8 knots in 24 hr. How many knots is this per hour?

WHERE IT RAINS THE MOST AND THE LEAST

This table, taken from a United States weather report, gives the number of inches of rain that fell in a recent year at three places:

	Ketchikan, Alaska	Redlands, Calif.	Indio, Calif.
Jan.	10.86	2.14	.02
Feb.	18.53	1.13	.01
Mar.	17.32	.91	.01
Apr.	13.23	2.32	.00
May	11.37	.00	.00
June	3.32	.00	.00
July	2.34	.01	.01
Aug.	15.07	.02	.21
Sept.	11.88	.25	.02
Oct.	14.85	.26	.01
Nov.	31.32	1.97	.01
Dec.	22.80	2.54	.18

1. Find the total yearly rainfall for each place.

2. Find the average monthly rainfall for each place.

3. Find the average monthly rainfall at Redlands for the six driest months; for the six wettest months. Do these two averages explain why it is said that Redlands has a wet season and a dry season?

4. During November, how many more inches of rain fell at Ketchikan than at each of the other places?

5. Bob said, "The total yearly rainfall was 360 times as great at Ketchikan as at Indio." Was he right?

6. At Macon, Ga., 6.58 in. of rain fell one day in about 2 hr. Show that this is about 13.7 times as much rain as fell during the whole year at Indio.

GRADED EXERCISES

Divide the following and check the work by multiplying:

1. 4)4.92	**7.** 2)5.6	**13.** 8)3.68	**19.** 3).225
2. 5)9.25	**8.** 7)8.4	**14.** 4)1.96	**20.** 8).664
3. 6)6.12	**9.** 6)5.4	**15.** 5).615	**21.** 4).312
4. 2)4.92	**10.** 8)5.6	**16.** 2).494	**22.** 7).336
5. 9)11.7	**11.** 3)1.2	**17.** 6)4.404	**23.** 8).472
6. 7)37.8	**12.** 5)2.5	**18.** 9)3.132	**24.** 9).531

Divide the following and check the work:

25. \$74.75 ÷ 23	**37.** 262.14 ÷ 51	**49.** 378.51 ÷ 93
26. \$65.19 ÷ 41	**38.** 605.13 ÷ 69	**50.** 841.28 ÷ 88
27. \$81.84 ÷ 33	**39.** 334.08 ÷ 87	**51.** 36.801 ÷ 47
28. \$118.57 ÷ 71	**40.** 3693.3 ÷ 39	**52.** 5970.6 ÷ 62
29. \$102.30 ÷ 62	**41.** 1674.4 ÷ 23	**53.** 121.38 ÷ 21
30. \$125.86 ÷ 31	**42.** 49.558 ÷ 71	**54.** 14.161 ÷ 49
31. \$545.57 ÷ 89	**43.** 227.07 ÷ 27	**55.** 2534.6 ÷ 29
32. \$521.60 ÷ 64	**44.** 41.595 ÷ 59	**56.** 346.15 ÷ 43
33. \$453.74 ÷ 49	**45.** 2900.2 ÷ 34	**57.** 15.862 ÷ 22
34. \$200.64 ÷ 38	**46.** 39.024 ÷ 72	**58.** 2878.2 ÷ 78
35. \$104.16 ÷ 84	**47.** 538.67 ÷ 59	**59.** 342.65 ÷ 55
36. \$206.77 ÷ 29	**48.** 3892.7 ÷ 83	**60.** 192.28 ÷ 76

AVOIDING REMAINDERS IN DIVISION

1. Margaret earned \$35 in 4 wk. How much did she earn each week?

You could divide as in *A*, getting a quotient of $\$8\frac{3}{4}$; but if you write \$35 as \$35.00 before you divide, as in *B*, you avoid having a remainder.

A	*B*
4)\$35	4)\$35.00
\$ $8\frac{3}{4}$	\$ 8.75

Margaret earned $\$8\frac{3}{4}$, or \$8.75, each week.

2. Last week-end Philip walked 16 hr. in all, and covered 52 mi. How many miles did he average per hour?

You could divide 52 by 16 and get a quotient of $3\frac{1}{4}$; but if you write 52 as 52.00 before dividing by 16, you can avoid the remainder.

Philip averaged $3\frac{1}{4}$ mi., or 3.25 mi., per hour.

Check the work by multiplying 3.25 by 16.

```
3.25
16)52.00
48
40
32
80
80
```

To avoid remainders in division, annex zeros after the decimal point of the dividend and continue to divide.

Problems

First divide, expressing each remainder by a fraction. Then work the problem again by annexing zeros.

1. A bakery used 225 bbl. of flour in one year. How many barrels was this per month?

2. John buys a radio for \$27. If he pays for it in 12 installments, how much does he pay each time?

3. A 25-story building is 381 ft. high. How many feet high is each story?

4. A hotel uses 132 lb. of butter in 5 days. What is the average number of pounds used in a day?

CHANGING A COMMON FRACTION TO A DECIMAL

Jack got $8\frac{3}{4}$ as an answer to a problem and David got 8.75. Jack thought that David was wrong, but Jean said that they were both correct because $\frac{3}{4}$ can be changed to .75. Jean was right.

In changing $\frac{3}{4}$ to a decimal, remember that $\frac{3}{4}$ means $3 \div 4$. Write 3 as 3.00 and divide by 4. The result is .75. Hence $\frac{3}{4} = .75$.

$$4\overline{)3.00}\quad .75$$

To change a common fraction to a decimal, put a decimal point after the numerator, annex zeros, and divide by the denominator.

Change the following fractions to decimals:

1. $\frac{1}{2}$	4. $\frac{1}{5}$	7. $\frac{1}{4}$	10. $\frac{1}{8}$	13. $\frac{3}{8}$	16. $\frac{2}{5}$
2. $\frac{9}{10}$	5. $\frac{5}{8}$	8. $\frac{7}{8}$	11. $\frac{3}{5}$	14. $\frac{1}{16}$	17. $\frac{4}{25}$
3. $\frac{2}{25}$	6. $\frac{3}{20}$	9. $\frac{11}{20}$	12. $\frac{7}{10}$	15. $\frac{13}{20}$	18. $\frac{3}{16}$

Changing to an Incomplete Decimal

In changing $\frac{2}{3}$ to a decimal, by annexing one 0, you get $\frac{2}{3} = .6\frac{2}{3}$; by annexing two 0's, you get $\frac{2}{3} = .66\frac{2}{3}$; by annexing three 0's, you get $\frac{2}{3} = .666\frac{2}{3}$. Hence you always have a remainder, no matter how far you carry the division. You usually say that $\frac{2}{3} = .66\frac{2}{3}$. The expression $.66\frac{2}{3}$ is called an **incomplete decimal.** In the same way, $\frac{1}{3}$ is equal to $.33\frac{1}{3}$, which is another incomplete decimal.

$$3\overline{)2.0}\quad .6\tfrac{2}{3} \qquad 3\overline{)2.00}\quad .66\tfrac{2}{3} \qquad 3\overline{)2.000}\quad .666\tfrac{2}{3}$$

Change to incomplete decimals with two decimal places:

1. $\frac{1}{6}$	3. $\frac{5}{6}$	5. $\frac{4}{7}$	7. $\frac{2}{15}$	9. $\frac{3}{13}$	11. $\frac{7}{9}$
2. $\frac{1}{9}$	4. $\frac{3}{11}$	6. $\frac{5}{9}$	8. $\frac{1}{12}$	10. $\frac{5}{12}$	12. $\frac{1}{7}$

EXPRESSING REMAINDERS AS DECIMALS

Divide. If there is a remainder, put a decimal point and two 0's after the dividend and continue dividing. Check:

1. \$18 ÷ 8
2. \$76 ÷ 8
3. \$52 ÷ 16
4. \$98 ÷ 25
5. \$78 ÷ 24
6. \$66 ÷ 24
7. \$570 ÷ 6
8. \$210 ÷ 56
9. \$168 ÷ 32
10. 312 ÷ 32
11. 147 ÷ 25
12. 243 ÷ 25
13. 146 ÷ 25
14. 325 ÷ 52
15. 174 ÷ 25
16. 247 ÷ 25
17. 266 ÷ 56
18. 368 ÷ 64
19. 166 ÷ 25
20. 231 ÷ 25
21. 189 ÷ 36
22. 234 ÷ 24
23. 8550 ÷ 75
24. 1044 ÷ 144
25. 1599 ÷ 164
26. 1687 ÷ 175
27. 2926 ÷ 616

Sometimes the division will come out exact if you write only one 0 after the dividend. Try it in these exercises:

28. 45 ÷ 18
29. 110 ÷ 4
30. 129 ÷ 15
31. 594 ÷ 45
32. 396 ÷ 88
33. 306 ÷ 45
34. 441 ÷ 35
35. 312 ÷ 48
36. 527 ÷ 62
37. 343 ÷ 98
38. 1032 ÷ 48
39. 1148 ÷ 35
40. 3042 ÷ 52
41. 5586 ÷ 95
42. 1001 ÷ 154

Divide, writing enough 0's after the dividend to make the division come out exact. Check the work:

43. 595 ÷ 68
44. 624 ÷ 75
45. 483 ÷ 75
46. 638 ÷ 88
47. 858 ÷ 88
48. 66.7 ÷ 92
49. 21 ÷ 24
50. 35 ÷ 56
51. 71.3 ÷ 92
52. 112 ÷ 128
53. 116 ÷ 125
54. 104 ÷ 125
55. 36.3 ÷ 44
56. 50.7 ÷ 52
57. 1617 ÷ 55
58. 1195 ÷ 125
59. 1743 ÷ 175
60. 101.5 ÷ 116

PROBLEMS

In the following exercises, if there is a remainder in a problem in division, annex zeros to the dividend and continue to divide until there is no remainder.

1. For Christmas Jean wants to buy her brother a ukulele costing $7.25. She has 5 wk. in which to save the money. How much should she save each week?

2. The speed of a raven is said to be 39 mi. an hour. At this rate, how many hours would it take a raven to fly a distance of 93.6 mi.?

3. Nat's father made an automobile trip of 130.5 mi. last Saturday on 9 gal. of gasoline. How can Nat find out how many miles the automobile makes on 1 gal. of gasoline? What is the answer?

4. A special train carrying the President of the United States made a trip of 234.2 mi. in 4 hr. Find the average speed of the train.

5. Mr. Hall's expenses for running his automobile during July came to $64.80. If he drove 864 mi., find the cost per mile of running his car.

6. During August Mr. Hall drove his automobile 2125 mi. His expenses for this month were $178.50. Find the cost per mile for August. What might have happened to make it cost more per mile in August than in July?

7. There are 94 pupils in the fifth grade of the Foster School. If these pupils deposited a total of $15.51 in the School Savings Bank last week, what was the average amount deposited by each pupil?

MAPLE SUGAR

1. A Vermont sugar orchard containing 2780 maple trees produced 8618 lb. of maple sugar. Find the average number of pounds produced per tree.

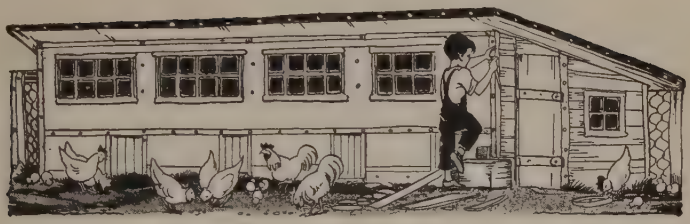
2. To produce 8618 lb. of sugar, it was necessary to gather and evaporate 215,450 lb. of maple sap. What part of the sap was sugar?

3. It takes 8 lb. of maple sugar to make 1 gal. of maple sirup. How many gallons of sirup can be made from 8618 lb. of sugar?

4. Much of the maple sirup sold is adulterated by mixing it with ordinary sugar. A merchant used 3 lb. of maple sugar costing 15¢ a pound and 5 lb. of white sugar costing 5¢ a pound to make a gallon of " maple " sirup, which he sold for $2.45. How much did it cost him per gallon and what was his profit?

5. Another merchant mixed 5 lb. of high-grade maple sugar costing 24¢ a pound with 3 lb. of white sugar costing 5¢ a pound to make a gallon of " maple " sirup, which he sold for $3.00. How much was his profit?

HENRY'S CHICKENS



1. Henry wished to build a henhouse large enough for 60 hens. He was told that he should allow 5 sq. ft. of floor space for each hen. Would a house with a floor space $12' \times 20'$ be large enough? a house $12' \times 26'$?

2. Henry read that a henhouse should cost not over \$1.75 per hen housed. Henry paid \$73.20 for his house for 60 hens. How much per hen did his house cost?

3. Henry read also that he should feed each hen an average of 40 lb. of grain and 37.5 lb. of mash per year. If he followed this advice, how many pounds of grain did he buy for his 60 hens in a year and what was its cost at \$2.83 per 100 lb.? How many pounds of mash did he buy and what was its cost at \$2.87 per 100 lb.?

4. Add the expenses for grain and mash (ex. 3) to the \$73.20 paid for the henhouse and find Henry's total expense for the first year.

5. In a year Henry got 8760 eggs. How much did he receive for them if he sold them at an average of 55¢ a dozen? What was his total profit for the year if his total expenses for the year were \$205.70?

6. Might Henry expect his profit for the second year to be more or less than that for the first year? Why?

MISCELLANEOUS PROBLEMS

1. Frank weighs 84 lb. and Ruth weighs 63 lb. Joe says that Ruth weighs $\frac{2}{3}$ as much as Frank. Is he right? If not, how does Ruth's weight compare with Frank's?

2. If you weighed 64 lb. a year ago and now weigh 80 lb., how many times as heavy are you now as you were a year ago? Write your answer as a mixed number and also as a mixed decimal with two decimal places.

3. Last year the Athletes played 25 baseball games and won .52 of them. How many games did they win?

4. Mrs. Parks wants to give each of the 30 children at Ida's party $\frac{1}{4}$ lb. of candy. How much will the candy cost at 58¢ a pound?

5. This chart shows how many inches of snow fell each month one winter in four of our cities. Find the total snowfall for each city. How much more snow fell in Albany than in each of the other cities?

	Omaha	Seattle	Albany	Raleigh
Dec.	0.5	11.2	17.1	0.6
Jan.	7.6	1.0	34.6	0
Feb.	0.7	17.4	9.6	0.1
Mar.	28.8	0.7	5.8	0

6. Each girl in a relay race ran 50 yd. The first girl on the Wilson Team took $8\frac{1}{5}$ sec., the second took $8\frac{7}{10}$ sec., the third took $9\frac{1}{2}$ sec., and the fourth took $8\frac{3}{5}$ sec. In how much more or less than 1 min. did the Wilson Team run the relay?

7. Mr. Nye drove his car 8 hr. at an average of 28.7 mi. an hour. He used 14 gal. of gasoline. How many miles did his car average per gallon of gasoline?

A HUT IN THE WOODS

1. On a clearing measuring 14 ft. by 9 ft. 6 in., some children built a hut whose floor measured 7 ft. 4 in. by $7\frac{1}{2}$ ft. How many square feet of clear land were there around the hut?

2. In front of the hut they made an aquarium 21 in. long, 14 in. wide, and $12\frac{1}{2}$ in. deep. If 231 cu. in. make 1 gal., how many gallons of water would fill the aquarium to within 1 in. of the top?

3. With a string 60 ft. long, Dennis measured the path from his home to the hut. The path was exactly 77 times as long as the string. What part of a mile was the length of the path?

4. For a picnic at the hut Dennis carried up $2\frac{1}{2}$ lb. apples, $3\frac{3}{8}$ lb. potatoes, $1\frac{3}{4}$ lb. steak, $\frac{3}{4}$ lb. tomatoes, and 2 oz. salt and pepper. He said, "This bundle weighs a ton." How many pounds less than a ton did it weigh?

Reviewing Measurements

Tell what numbers should be put in place of the dots:

1. 45 in. = . . . yd.
2. $6\frac{1}{2}$ yd. = . . . in.
3. 80 rd. = . . . mi.
4. $5\frac{1}{2}$ mi. = . . . ft.
5. $10\frac{1}{2}$ gal. = . . . qt.
6. 110 qt. = . . . gal.
7. 19 bu. = . . . pk.
8. $2\frac{1}{2}$ bu. = . . . pt.
9. 75 lb. = . . . cwt.
10. 2.5 lb. = . . . oz.
11. $3\frac{1}{4}$ min. = . . . sec.
12. 1.1 hr. = . . . min.

13. Find the area of a rectangle that is $8\frac{1}{2}' \times 7'$.

14. Which has the greater volume, a box that is 6 ft. $\times 4\frac{1}{2}$ ft. $\times 4$ ft. or a box that is $8\frac{1}{3}$ ft. $\times 6$ ft. $\times 2$ ft.?

REVIEW OF FRACTIONS

Add. Check by going over the work again:

1.	2.	3.	4.	5.
$6\frac{1}{4}$	$9\frac{7}{8}$	$6\frac{5}{6}$	$3\frac{1}{10}$	$9\frac{1}{3}$
$5\frac{1}{8}$	$2\frac{1}{16}$	$4\frac{2}{3}$	$2\frac{3}{5}$	$7\frac{3}{4}$
$8\frac{5}{8}$	$4\frac{1}{4}$	$8\frac{1}{2}$	$5\frac{1}{2}$	$2\frac{5}{8}$

Subtract. Check the work by going over it again:

6.	7.	8.	9.	10.
$9\frac{1}{2}$	$6\frac{1}{10}$	$9\frac{3}{4}$	$6\frac{2}{3}$	$5\frac{1}{4}$
$2\frac{3}{8}$	$5\frac{3}{10}$	$7\frac{3}{8}$	$1\frac{1}{2}$	$3\frac{5}{6}$

Do the following. Check by going over the work:

11. $\frac{3}{4}\times 20$	17. $\frac{3}{2}\times\frac{5}{6}$	23. $25\div\frac{5}{6}$	29. $\frac{5}{8}\div\frac{2}{3}$
12. $\frac{5}{8}\times 48$	18. $1\frac{1}{2}\times 41$	24. $18\div\frac{16}{5}$	30. $\frac{9}{10}\div\frac{2}{5}$
13. $\frac{3}{8}\times 28$	19. $1\frac{1}{3}\times 1\frac{1}{2}$	25. $\frac{7}{10}\div 4$	31. $7\frac{1}{2}\div\frac{5}{8}$
14. $84\times\frac{5}{6}$	20. $2\frac{3}{4}\times 92$	26. $\frac{4}{5}\div 10$	32. $1\frac{7}{8}\div\frac{3}{4}$
15. $16\times 9\frac{1}{2}$	21. $\frac{5}{16}\times\frac{12}{15}$	27. $1\frac{1}{4}\div 5$	33. $1\frac{2}{3}\div 6\frac{1}{2}$
16. $26\times 7\frac{1}{4}$	22. $7\frac{1}{5}\times 3\frac{1}{8}$	28. $3\frac{3}{4}\div 9$	34. $10\div 3\frac{1}{7}$

Multiplication and Division of Decimals

In the division problems, express remainders as decimals:

1. 6×84.3	10. 6.2×1.4	19. $3234\div 55$
2. 8×19.5	11. $2.9\times .03$	20. $1662\div 24$
3. $4\times .018$	12. $.27\times 3.8$	21. $7938\div 105$
4. 7×2.06	13. $.02\times 0.4$	22. $53.94\div 87$
5. 12×8.75	14. $250\times .007$	23. $332.5\div 95$
6. $48\times .362$	15. $.406\times 999$	24. $304.5\div 116$
7. $95\times .008$	16. 45.1×33.6	25. $802.9\div 124$
8. $.16\times 541$	17. $507.6\div 12$	26. $43.384\div 34$
9. 3.1×705	18. $61.36\div 13$	27. $63.679\div 77$

CHAPTER III

GETTING INTO PRACTICE AGAIN

Every fall when the boys begin to play football, they find that they must work hard to get their game into good form because they are "out of practice."

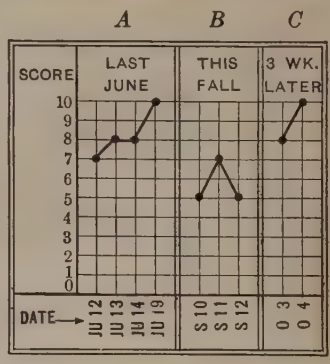
In the same way, if you have not had to add or subtract during the summer, you now find in computing that you, too, are "out of practice." You must get your arithmetic back into good form as soon as possible.

Last year you probably kept a careful record (as suggested on page 14) of your progress in the Improvement Tests. Look up this record and see how well you did in Improvement Test No. 10 A at the end of last year. Try the same test now and see how well you can do in it. Your score will probably be below your former records; hence *you need more practice.*

The best way to gain skill in computing is *always to try to improve on your best previous record.*

HOW EDNA IMPROVED IN ADDITION

Edna looked up her last Graphic Record Book and found that her scores in Improvement Test 10 A (page 141) were as shown in graph *A* at the right.



To see if she could do as well this fall, Edna tried Test 10 A again the first week of school and was disappointed to find that her scores were low, as shown in *B*. She therefore practiced some of last year's Improvement Tests in addition, such as Tests 1 A, 2 A, and 8 A. Then she practiced Test No. 13 A, on page 185. After three weeks she tried Test 10 A again, and made the scores shown in graph *C*. Did Edna beat her former record this time?

Reading Edna's Record

1. What was Edna's lowest score last June?

2. What was her score on Sept. 10? Sept. 11? Sept. 12?

3. How many times did Edna try the test in June before she scored 10?

4. When Edna took the test in October, how many trials did she have to make to get a score of 10? Was this record, as given in *C*, better than her record in June?

NOTE. Each pupil should get a notebook of squared paper and keep a graphic record of his scores in all the Improvement Tests throughout the year. See pages 12 to 14 for further directions.

IMPROVEMENT TEST No. 13

Test 13 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.
5484	7074	1537	7421	5612
629	9737	6106	598	341
8432	4461	9722	779	21
265	970	70	6444	8815
9075	994	8799	8870	2309
6115	7046	553	7208	6821
7236	8568	5838	917	6743
660	5139	6373	4454	97

Test 13 B — Subtraction (Time 3 min.)

1.	2.	3.	4.
94213	49101	99752	32510
61904	41941	70864	13778
5.	**6.**	**7.**	**8.**
97059	88730	43730	84041
41298	59760	20475	63488
9.	**10.**	**11.**	**12.**
94831	98360	48364	57000
19254	58456	29075	20631

Test 13 C — Multiplication (Time 3 min. after copying)

1.	2.	3.	4.	5.
4952	8673	7683	6972	2549
76	507	48	93	28

Test 13 D — Division (Time 4 min. after copying)

1. $29\overline{)15586}$ 2. $62\overline{)32064}$ 3. $47\overline{)42065}$

4. $88\overline{)54208}$ 5. $31\overline{)64418}$

READING LARGE NUMBERS

In newspapers and magazines you often see very large numbers representing *millions* and *billions*.

1,000,000 is read 1 million and 1,000,000,000 is read 1 billion. Thus, 1 million is another name for 1000 *thousand*, while 1 billion means 1000 *million*.

You have learned to divide large numbers into periods of 3 figures each by commas, beginning at the right. These periods have the following names:

Billions	Millions	Thousands	Units
27	165	023	015

Read this number *27 billion, 165 million, 23 thousand, 15*.

Exercises

These are headlines from newspapers. Read them:

1. Senate approves tax cut of $387,811,000.
2. Rich man leaves $8,500,000 for art.
3. Country used 1,293,184,528 post cards in a year.

Read the populations of these 10 *largest cities in the world:*

4. London	7,480,000	9. Buenos Aires	2,310,000
5. New York	5,620,000	10. Osaka	2,155,000
6. Berlin	4,014,000	11. Moscow	2,018,000
7. Paris	2,871,000	12. Tokyo	1,996,000
8. Chicago	2,702,000	13. Vienna	1,866,000

14. See how many large numbers you can find in newspapers. Bring them to class and read the large numbers.

15. Read several large numbers which you find on the last pages of your geography.

USING ADDITION

1. From a mail-order house Ralph ordered an overcoat for \$11.95, a sled for \$2.95, a set of tools for \$3.50, and a football for \$5.75. He sent \$.52 postage with the order. How much money did he send in all?

2. Dick has a bank account at the Eastern Savings Bank. Last year he deposited \$35.00, \$7.85, \$11.98, \$4.50, and \$15.75. How much did Dick deposit last year?

3. Jane is treasurer of a club at the Trent School. She collected these amounts for a new radio set: \$5.87, \$9.65, \$7.53, \$15.25, \$11.67. How much could they spend for the radio set?

4. May's mother buys the following new furnishings for May's room: a rocking chair for \$5.95, a pair of curtains for \$3.15, a fancy pillow for \$1.25, and a writing desk for \$7.95. How much do these cost?

5. How many miles of railroad are there in New England if there are 2228 mi. in Maine, 1057 mi. in Vermont, 1234 mi. in New Hampshire, 2071 mi. in Massachusetts, 196 mi. in Rhode Island, and 969 mi. in Connecticut?

6. In a recent year the mineral products of California were valued at \$428,175,652, those of Oregon at \$7,364,232, and those of Washington at \$21,159,370. What was the total value of the mineral products of the Pacific States?

7. Find the population of the world if there are 136,000,000 people in North America, 64,000,000 in South America, 142,000,000 in Africa, 921,000,000 in Asia, 476,000,000 in Europe, and 9,000,000 in Australasia.

USING SUBTRACTION

1. The Thorley School has 2519 pupils, of whom 1298 are boys. How many girls attend this school?

2. Grace had $48.14 in the school savings bank. She drew out $3.95 to buy a birthday present for her mother. How much did she still have in the bank?

3. Mr. Root paid $10,575 for a house which he later sold for $14,050. How much had the value of the house increased?

4. David has earned $98.50. He wants to make a trip to California, which will cost him $250. How much more will the trip cost than David has earned?

5. The population of Virginia was 1,225,163 in 1870 and 2,309,187 in 1920. How many inhabitants did Virginia gain during these fifty years?

6. The United States, with its outlying possessions, has about 117,859,495 inhabitants, while France, with her colonies, has only about 96,375,035. How much less is the population of France than that of our country?

7. Recently there were 15,369,404 telephones in the United States and 1,009,258 telephones in Canada. What was the difference between the number of telephones in these countries?

8. One year there were 15,597,628 automobiles in the United States and 154,208 in Germany. How many more cars were there in the United States than in Germany?

9. Ohio had 272,045 farms one year and 256,695 farms ten years later. Did the number of farms in Ohio increase or decrease during these ten years? how much?

USING MULTIPLICATION

1. Frank works in a large wholesale toy store. If he sells 235 toy taxicabs at $1.67 each, how much will the bill for them amount to?

2. The Park School sold 239 tickets to its play at 75¢ each, 165 tickets at 50¢ each, and 210 tickets at 35¢ each. How much money was collected in all from these sales?

3. A school bookstore sold 348 readers at 85¢ each and 415 arithmetics at 75¢ each. How much money was collected from the sale of these books?

4. In one year 8640 electric bulbs were sold to a department store. At an average of 28¢ each, how much was paid for these bulbs?

5. Mr. Wills sold 238 doz. eggs at 45¢ a dozen, 315 doz. at 48¢ a dozen, 214 doz. at 43¢ a dozen and 237 doz. at 46¢ a dozen. How much did he receive in all?

6. Belle is going to save $1.75 each week out of the money she earns. How much will she have at the end of 28 wk.? 39 wk.? 42 wk.? a year?

7. Elsa's older brother, Dick, earns $18.75 a week in a factory. If he works 51 weeks in a year, how much money does he earn?

8. An airplane can travel 125 mi. an hour. How much further can you ride in such an airplane in 12 hr. than in a train which goes 35 mi. an hour?

9. An automobile factory produces, on an average, 12,835 passenger cars and 425 delivery cars a week. How many cars in all will it produce in a year?

USING DIVISION

1. It costs an average of $306.60 to feed each lion at the Doho Circus for 1 year (365 days). Find the average cost per day to feed each lion.

2. Jane has $15.05 with which to buy 43 yd. of white lawn for aprons for her sewing class. How much per yard can she pay for the lawn?

3. It cost Mr. Franklin $391.20 to run his car 4890 mi. Find out how much per mile it cost him.

4. It cost Mr. Jenkins, a landlord, $618.00 to heat his apartment house for 125 days during the winter. Find, to the nearest cent, how much per day it cost him.

5. Mrs. Thomas is buying a piano for $350.50. She agrees to pay $62.50 cash and $16 a month till the piano is paid for. How many months will it take her to pay for the piano?

6. Mr. Dale and his family are making an automobile trip of 3180 mi. from New York to San Francisco. They want to make the trip in 30 days. How many miles a day should they average?

7. At a sale Mrs. Peck bought 29 yd. of cretonne for $6.96. How much per yard did she pay?

8. A factory which employs 295 men has a total weekly payroll of $8968. Find the average weekly salary of a workman.

9. Mr. Hart buys a house for $16,000. He pays $3400 cash and agrees to pay the rest in equal monthly installments covering 144 months. How much will he pay in each installment?

SOLVING HARDER PROBLEMS

Guy Jones works in a factory which employs 156 men. He gets 45¢ an hour for regular work and $1\frac{1}{2}$ times that rate for overtime. Last week he worked 53 hr., of which 8 hr. were overtime. What were his earnings last week?

In solving harder problems, ask yourself these questions:

1. *Do I understand the problem?* What do "overtime" and "$1\frac{1}{2}$ times that rate" mean?

2. *What am I asked to find?* You are here asked to find Guy's earnings for the week.

3. *What facts are given?* Four of the facts given in the problem must be used to solve it. What are they? Are any facts given that are not needed?

4. *What steps shall I take to obtain the answer?* To find Guy's earnings you must answer these questions:

(1) How many hours of regular work did Guy do?
53 hr. − 8 hr. = 45 hr., the number of hours of regular work.

(2) How much did he earn for regular work?
$45 \times 45¢ = \$20.25$, his earnings for regular work.

(3) How much did he earn for 1 hour of overtime?
$1\frac{1}{2} \times 45¢ = 67\frac{1}{2}¢$, his earnings for 1 hr. of overtime.

(4) How much did he earn in all for overtime?
$8 \times 67\frac{1}{2}¢ = \$5.40$, his earnings for 8 hr. of overtime.

(5) What were Guy's total wages?
$\$20.25 + \$5.40 = \$25.65$, his total wages.

5. *Have I found what was asked for?* Read the problem again to see if you have answered the question asked.

6. *Is the work right?* Go over all your steps to see if your thinking is right. Then check your computations.

CAN YOU DO THESE HARDER PROBLEMS?

1. Mr. Coss and 3 of his friends rent a fishing boat. They have the boat 5 hr. at \$.65 an hour, and they pay \$1.55 for bait. Find how much each man must pay if they share the total expenses equally.

2. Mrs. Peel is buying a vacuum cleaner on the installment plan. The clerk says that there are two ways of paying for it. The first plan is to pay \$15 cash and then pay \$4.50 a month for 11 mo. The second plan is to pay \$25 cash and \$5.75 a month for 6 mo. Which plan is cheaper and how much cheaper?

3. Henry and Jim wanted to sell their canoe. They put a 3-line advertisement in the *Daily News* for 4 days at 45¢ a line each day. Tom saw the advertisement and bought the canoe for \$37.50. If Henry and Jim divided the money equally, how much did each boy get from the sale after the advertising expense was deducted?

4. Mr. Bates and his family are making an automobile trip of 3312 mi. across the United States. If they drive 8 hr. a day at an average speed of 18 mi. an hour and allow 5 days for stopovers and repairs, how many days must they allow for the trip?

5. Each of the 32 children in the primary grades of our school gave 15¢ to a Thanksgiving fund for poor families. Each of the 27 children in the grammar grades gave twice as much as that. How much did our school contribute?

WHAT MUST YOU KNOW TO WORK THESE PROBLEMS?

1. Jack wants to find out at what time he must leave his house in the morning in order to reach school on time. Kitty says that he must first know how long it takes him to reach school and at what time he is due there. Then he must subtract the time it takes him from the time when he is due. Is Kitty right?

2. Carl needs some rope to make a swing on the apple tree. What must he know and then what must he do to find how much the rope will cost?

3. Mr. Johnson is buying an automobile on the installment plan. He is paying for it in equal monthly installments. What must he know and then what must he do to find how many payments he will have to make?

4. What must you know and then what must you do to find how much more money you have in the savings bank this June than you had last September?

5. How can a grocer find out how many $3\frac{1}{2}$-pound bags of flour he can fill from a barrel of flour?

6. Suppose that an airplane makes a trip from New York to Denver. What must you know and what must you do to find how fast per hour the airplane travels?

7. If you know the number of miles your automobile can travel on 1 gal. of gasoline, what else must you know and what must you do to find how much gasoline you need to make a certain trip?

8. During the summer Arthur sells books at $2.00 each. Mr. Dick asks Arthur how much his profits average per week. How can Arthur find out?

GIVE THE MISSING FACT

In each problem a fact is missing which you must know before you can find the answer. Supply the missing fact and work the problem.

1. There are 24 sandwiches for the children at the picnic. How many will each child get?

The missing fact is the number of children at the picnic. If there are 6 children, each will get 24 sandwiches ÷ 6, or 4 sandwiches.

2. Arthur waited at the station for a train to arrive. It was due at 3.15 P.M., but was delayed. How late was the train?

3. Mr. Smith buys a paper every Sunday. How much does he spend in 1 year for his Sunday papers?

4. How much will $4\frac{1}{2}$ doz. new marbles cost James?

5. Harry is saving $\frac{2}{5}$ of the money he earns this summer. How much will he save this summer?

6. Janet wants a new couch cover. She sees some material costing $1.14 a yard. If she buys this material, how much will the cover cost?

7. In Jennie's family they use $10\frac{1}{2}$ doz. rolls a week. How much is spent each week for rolls?

8. The 27 children in our class are going by boat to Indian Point. How much will all the tickets cost?

9. Ruth has $5 to spend for goods for her dress. How much per yard can she pay for the goods?

10. Mr. Owen is driving 1053 mi. from New York to Chicago. How long will the trip take?

11. Tom is buying a typewriter for $60 on the installment plan. How long will it take him to pay for it?

WHAT QUESTION SHOULD BE ASKED?

The following problems are not complete because no question has been asked. Finish each problem by asking a question which can be answered by using the facts given. Then find the answer to your question.

1. Some boys rented a rowboat on Bronx Lake for 6 hours at 50¢ an hour.

The missing question is " How much did they pay in all? " Answer this question.

2. Each of the 47 children in our class is giving a nickel to buy some plants for the schoolroom.

3. Nell was queen of the June walk. She needed $2\frac{1}{8}$ yd. of white satin at \$1.12 a yard for her dress and $1\frac{3}{4}$ yd. of tinsel at \$.28 a yard.

4. Pat was born in 1918 and his sister Kathleen was born in 1925.

5. Janet has read 117 pages of a 205-page book.

6. Jack and Tom bought a small tent for \$11.95. At the end of the summer they sold it for \$5.50.

7. Last month Jim worked after school for Mr. Dean for 49 hr. at 18¢ an hour. When Mr. Dean paid him he handed him a 10-dollar bill.

8. This morning Ida rode her bicycle 4 mi. in 20 min.

9. It is 710 mi. by train from New Orleans to St. Louis and you pass through Memphis, Tenn., on the way. It is 394 mi. from New Orleans to Memphis.

10. It took Ned $3\frac{1}{2}$ hr. to clean Mrs. Fisk's cellar. He received 28¢ an hour. He gave half of what he earned to his mother and spent 15¢ for the movies.

ARE YOU A GOOD THINKER?

In each problem, some numbers are given that are not needed for finding the answer. Tell which numbers are not needed and then solve the problem.

1. Henry is going to camp for 14 da. He needs \$45 for board and fare. He has \$38.79 and his father is giving him the rest. How much is his father giving him?

In finding the answer, you do not use the fact that Henry is going to camp for 14 da.

2. A 36-car freight train traveled 475 miles in 25 hr. Find its average speed per hour.

3. Mr. and Mrs. Felton rent a 5-room apartment for \$57 a month. How much rent will they pay in $\frac{1}{2}$ yr.?

4. Seven persons are going on an automobile trip of 1210 mi. If they ride 220 mi. a day, how many days will it take them to make the trip?

5. Jack wants to buy a radio set for \$38.50. He has worked 17 da. and has earned \$29.75 in all. How much more must he earn to buy the set?

6. At a sale Milton bought for \$14.95 a suit originally marked \$18.75. How much money did he have left from the \$20.00 which he had saved?

7. Frank attends school from 8.30 A.M. to 12.30 P.M. and from 1.30 P.M. to 3 P.M. How much time has he for lunch?

8. John gets \$1.50 a week. Last week he paid 35¢ for $3\frac{1}{2}$ doz. marbles. How much money had he left?

9. There are 1396 children at the Lawrence School. If 964 of them contribute 10¢ each to a charity, how much money is collected at the school?

LIVING MORE THAN 1000 YEARS

Think very carefully in working these problems.

1. It is said that Methuselah lived 969 yr. How long would it have taken him to haul $\frac{1}{2}$ ton of stone on an ox cart to a city 20 mi. away and to return, if his oxen went 2 mi. an hour and he traveled 10 hr. a day?

2. If Methuselah worked 300 da. a year at the rate given in ex. 1, how many tons could he have hauled to the city in 900 yr.?

3. How many years would it take a modern man with an auto truck carrying 3 tons at a time to haul the same number of tons as in ex. 2, if he made 2 round trips daily to the city 20 mi. distant and worked 300 da. a year?

4. How many years would it have taken Methuselah, working 300 days a year, to cart as much stone to the city (see ex. 1 and 2) as a modern man, working at the rate given in ex. 3, could haul in 50 yr.?

5. How many men pulling an average of 60 lb. each would it have taken, when the pyramids of Egypt were built, to raise as much as an engineer does to-day with a modern derrick, if the derrick lifts 8 tons at a time and works 3 times as fast as the ancient human power hoist?

You see that to-day a man who lives to be 80 yr. old can accomplish a great deal more than a man in olden times could if he lived 1000 yr.

FRACTIONS

What You Know About Fractions

You have learned the following things about fractions:

1. A fraction can stand for *a part of one thing.* Thus, $\frac{3}{4}$ of 1 apple is a part of an apple.

2. A fraction can stand for *a part of a group* of things. Thus, $\frac{3}{4}$ of 16 boys, which equals 12 boys, is a part of a group of 16 boys.

3. A fraction can be used to express division. Thus, $\frac{3}{5}$ means $3 \div 5$ and $\frac{17}{4}$ means $17 \div 4$.

In everyday life you often change a half dollar into 5 dimes if 5 dimes are more convenient to use than a half dollar. You know that a half dollar and 5 dimes both have the *same value*, namely 50¢.

In the same way, you may change one fraction into another fraction having the *same value.* Thus, you may change $\frac{1}{2}$ to $\frac{4}{8}$ because $\frac{1}{2}$ is equal to $\frac{4}{8}$. Likewise you may change $\frac{4}{8}$ back to $\frac{1}{2}$ when you find it convenient to do so.

A quick way to change $\frac{1}{2}$ to $\frac{4}{8}$ is to multiply both terms of $\frac{1}{2}$ by 4, as shown in *A*.

$$A.\ \frac{1}{2} = \frac{1 \times 4}{2 \times 4} = \frac{4}{8}$$

Similarly, to change $\frac{8}{16}$ to $\frac{1}{2}$, you divide both terms of $\frac{8}{16}$ by 8, as shown in *B*.

$$B.\ \frac{8}{16} = \frac{8 \div 8}{16 \div 8} = \frac{1}{2}$$

If you multiply or divide both terms of a fraction by the same number, you get another fraction with the same value.

REDUCING FRACTIONS

1. There are 36 in. in 1 yd. What part of a yard is 1 in.? 5 in.? 9 in.?

2. Allen says that 9 in. is $\frac{1}{4}$ yd. because $\frac{9}{36} = \frac{1}{4}$. Is Allen right? By what number do you divide both terms of $\frac{9}{36}$ to change it to $\frac{1}{4}$?

3. Lucy has 27 in. of ribbon. What part of a yard is that? Then what does $\frac{27}{36}$ equal?

4. There are 1760 yd. in 1 mi. If Bert runs in the 220-yard dash, what part of a mile does he run? What does $\frac{220}{1760}$ equal?

In each fraction tell what number should be put in place of the star so that both fractions will be equal:

5. $\frac{1}{2} = \frac{*}{10}$ **6.** $\frac{5}{6} = \frac{*}{12}$ **7.** $\frac{2}{3} = \frac{*}{6}$ **8.** $\frac{3}{4} = \frac{*}{12}$ **9.** $\frac{3}{8} = \frac{*}{32}$ **10.** $\frac{1}{4} = \frac{*}{32}$ **11.** $\frac{7}{8} = \frac{*}{16}$ **12.** $\frac{6}{8} = \frac{*}{24}$

Change each fraction as indicated:

13. $\frac{3}{4}$ to 16ths **14.** $\frac{1}{2}$ to 12ths **15.** $\frac{2}{9}$ to 36ths **16.** $\frac{3}{8}$ to 24ths **17.** $\frac{1}{4}$ to 60ths **18.** $\frac{1}{10}$ to 100ths **19.** $\frac{9}{10}$ to 100ths **20.** $\frac{3}{5}$ to 100ths **21.** $\frac{7}{10}$ to 100ths

Reduce to lowest terms, telling by what number you divide both terms of the fraction:

22. $\frac{8}{36}$ **23.** $\frac{15}{20}$ **24.** $\frac{64}{100}$ **25.** $\frac{18}{36}$ **26.** $\frac{30}{60}$ **27.** $\frac{80}{100}$ **28.** $\frac{40}{50}$ **29.** $\frac{65}{100}$ **30.** $\frac{12}{16}$ **31.** $\frac{20}{60}$ **32.** $\frac{27}{45}$ **33.** $\frac{8}{16}$ **34.** $\frac{24}{36}$ **35.** $\frac{30}{36}$ **36.** $\frac{12}{32}$ **37.** $\frac{48}{50}$ **38.** $\frac{20}{24}$ **39.** $\frac{18}{20}$ **40.** $\frac{25}{75}$ **41.** $\frac{6}{39}$ **42.** $\frac{8}{32}$ **43.** $\frac{36}{60}$ **44.** $\frac{98}{100}$ **45.** $\frac{25}{100}$

46. Count by $\frac{1}{4}$'s to 5, thus: $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, etc.

47. Count by $\frac{1}{8}$'s to 4; by $\frac{1}{16}$'s to 3; by $\frac{1}{6}$'s to 5.

IMPROPER FRACTIONS

Most of the fractions in common use, like $\frac{3}{4}$ and $\frac{2}{3}$, are smaller than 1 whole unit. Such fractions are called **proper fractions.**

There are some fractions, however, like $\frac{4}{4}$ and $\frac{10}{10}$, which are equal to 1 whole unit, and some other fractions, like $\frac{5}{4}$ and $\frac{15}{3}$, which are larger than 1 whole unit. Both these kinds of fractions are called **improper fractions.** An improper fraction is either equal to 1 or greater than 1.

You know that $\frac{6}{1} = 6 \div 1 = 6$. Any whole number may be written in the form of a fraction. Thus, 8 may be written as $\frac{8}{1}$.

Numbers like $5\frac{1}{4}$ and $16\frac{2}{3}$ are called **mixed numbers.**

Which of these are proper fractions? Which are improper fractions?

$\frac{5}{8}$ $\frac{7}{5}$ $\frac{3}{16}$ $\frac{6}{6}$ $\frac{7}{4}$ $\frac{10}{3}$ $\frac{11}{12}$ $\frac{12}{5}$ $\frac{8}{8}$ $\frac{10}{5}$

Reducing Improper Fractions to Mixed Numbers

1. Reduce $\frac{12}{8}$ to a mixed number.

Since $\frac{12}{8}$ means $12 \div 8$, divide 12 by 8, which gives $1\frac{1}{2}$.

To reduce an improper fraction to a whole number or a mixed number, divide the numerator by the denominator.

Reduce to whole numbers or to mixed numbers. Be sure that the fraction in the answer is in its lowest terms:

2. $\frac{15}{8}$	**6.** $\frac{19}{12}$	**10.** $\frac{18}{8}$	**14.** $\frac{15}{5}$	**18.** $\frac{10}{4}$	**22.** $\frac{19}{16}$
3. $\frac{10}{3}$	**7.** $\frac{20}{8}$	**11.** $\frac{25}{12}$	**15.** $\frac{18}{10}$	**19.** $\frac{13}{4}$	**23.** $\frac{26}{16}$
4. $\frac{48}{4}$	**8.** $\frac{41}{5}$	**12.** $\frac{39}{5}$	**16.** $\frac{11}{6}$	**20.** $\frac{17}{2}$	**24.** $\frac{13}{3}$
5. $\frac{37}{5}$	**9.** $\frac{45}{10}$	**13.** $\frac{45}{12}$	**17.** $\frac{55}{15}$	**21.** $\frac{104}{16}$	**25.** $\frac{65}{20}$

ADDING FRACTIONS

1. Alice used $2\frac{1}{2}$ yd. of ribbon on one dress, $1\frac{3}{8}$ yd. on a second dress, and $1\frac{3}{4}$ yd. on a third dress. How much ribbon did she use in all?

You cannot add fractions that have different names, hence you cannot add *halves*, *eighths*, and *fourths*. But you can add $\frac{1}{2}$, $\frac{3}{8}$, and $\frac{3}{4}$ if you first change them all to *eighths*, as shown at the right.

$$2\tfrac{1}{2} = 2\tfrac{4}{8}$$
$$1\tfrac{3}{8} = 1\tfrac{3}{8}$$
$$1\tfrac{3}{4} = 1\tfrac{6}{8}$$
$$5\tfrac{5}{8}$$

The sum of the fractions is $\frac{13}{8}$, which equals $1\frac{5}{8}$. Write $\frac{5}{8}$ and carry 1 to the whole numbers.

You find that Alice used $5\frac{5}{8}$ yd. of ribbon in all.

2. Gus walked $5\frac{1}{4}$ mi. on Thursday, $4\frac{1}{2}$ mi. on Friday, and $7\frac{1}{8}$ mi. on Saturday. How far did he walk in all?

To add fractions having different denominators, first change them to fractions having the same denominator.

Exercises

Add. Check the work by going over it again:

1. $7\frac{1}{2}$	**2.** $5\frac{3}{4}$	**3.** $4\frac{7}{8}$	**4.** $8\frac{1}{3}$	**5.** $9\frac{2}{5}$	**6.** $4\frac{2}{3}$
$4\frac{7}{8}$	$6\frac{7}{8}$	$3\frac{5}{8}$	$4\frac{5}{6}$	$5\frac{1}{2}$	$8\frac{5}{6}$
5	$9\frac{1}{2}$	$9\frac{1}{2}$	$5\frac{1}{2}$	$4\frac{3}{10}$	$9\frac{1}{2}$
7. $8\frac{4}{5}$	**8.** $5\frac{5}{12}$	**9.** $8\frac{3}{8}$	**10.** $9\frac{9}{10}$	**11.** $8\frac{5}{6}$	**12.** $5\frac{5}{16}$
6	$1\frac{1}{2}$	$1\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{2}{3}$	$2\frac{3}{4}$
$9\frac{7}{10}$	$2\frac{2}{3}$	$9\frac{1}{2}$	$4\frac{1}{5}$	$5\frac{5}{12}$	$4\frac{1}{2}$
13. $9\frac{7}{8}$	**14.** $7\frac{2}{3}$	**15.** $2\frac{9}{10}$	**16.** $5\frac{7}{12}$	**17.** $2\frac{1}{2}$	**18.** $1\frac{7}{8}$
$8\frac{1}{16}$	$5\frac{1}{2}$	$9\frac{2}{5}$	5	$3\frac{3}{4}$	$5\frac{7}{8}$
2	$4\frac{5}{12}$	1	$6\frac{1}{2}$	$5\frac{3}{8}$	$2\frac{3}{16}$
$6\frac{1}{2}$	$3\frac{1}{4}$	$8\frac{1}{2}$	$1\frac{1}{12}$	$4\frac{7}{16}$	$3\frac{3}{4}$

JANE SELLS FLOWERS

1. Jane has a flower garden. She sold Mrs. Blake $\frac{5}{6}$ doz. red roses, $1\frac{1}{2}$ doz. white roses, and $1\frac{1}{4}$ doz. pink roses. How many dozen roses did she sell in all?

You must change $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{5}{6}$ to fractions having the same denominator; hence you have to find a number that will exactly contain 2, 4, and 6. Since 12 is the smallest number that will contain each of these numbers, you choose 12 as the least common denominator.

Could you use 24 or 48 as the common denominator? Why is 12 better?

$$\begin{aligned} \tfrac{5}{6} &= \tfrac{10}{12} \\ 1\tfrac{1}{2} &= 1\tfrac{6}{12} \\ 1\tfrac{1}{4} &= 1\tfrac{3}{12} \\ \hline & \quad 3\tfrac{7}{12} \end{aligned}$$

2. Jane sold Mrs. Lee $1\frac{3}{4}$ doz. white asters and $1\frac{2}{3}$ doz. pink asters. How many dozen asters was that?

3. Ada bought $2\frac{1}{2}$ doz. zinnias, $\frac{1}{3}$ doz. dahlias, and $1\frac{3}{4}$ doz. salvias. How many dozen flowers was that?

Practice in Adding Fractions

Add. Review the rule on page 71 *for finding the least common denominator:*

1. $2\frac{2}{3}$	**2.** $9\frac{3}{4}$	**3.** $7\frac{1}{2}$	**4.** $8\frac{1}{3}$	**5.** $7\frac{1}{3}$	**6.** $8\frac{1}{2}$
$\frac{1}{4}$	$5\frac{1}{5}$	$4\frac{2}{5}$	$\frac{5}{6}$	$8\frac{3}{4}$	$3\frac{2}{3}$
$6\frac{7}{8}$	$2\frac{3}{10}$	$9\frac{3}{5}$	$1\frac{1}{8}$	$4\frac{5}{6}$	$6\frac{7}{8}$
7. $2\frac{2}{3}$	**8.** $9\frac{1}{2}$	**9.** $7\frac{1}{3}$	**10.** $7\frac{2}{3}$	**11.** $5\frac{1}{8}$	**12.** $3\frac{3}{4}$
$5\frac{1}{4}$	$5\frac{2}{5}$	$9\frac{5}{6}$	$4\frac{1}{6}$	$4\frac{3}{4}$	$8\frac{1}{5}$
$8\frac{2}{3}$	$\frac{7}{8}$	$\frac{5}{8}$	$6\frac{8}{9}$	$2\frac{3}{16}$	$1\frac{3}{10}$
13. $7\frac{3}{4}$	**14.** $9\frac{3}{8}$	**15.** $9\frac{2}{3}$	**16.** $5\frac{1}{2}$	**17.** $4\frac{1}{2}$	**18.** $4\frac{2}{3}$
$4\frac{1}{5}$	$1\frac{1}{3}$	$\frac{3}{4}$	$7\frac{3}{4}$	$\frac{5}{6}$	$9\frac{1}{8}$
$\frac{1}{4}$	$9\frac{7}{8}$	$1\frac{5}{6}$	$\frac{2}{3}$	$6\frac{1}{8}$	$8\frac{7}{12}$
$8\frac{4}{5}$	$5\frac{1}{2}$	$2\frac{1}{2}$	$8\frac{5}{6}$	$3\frac{2}{3}$	$8\frac{3}{4}$

REDUCING MIXED NUMBERS TO IMPROPER FRACTIONS

Anna has $\$6\frac{3}{4}$ and she wishes to change it all to *quarters*. How many *quarters* will she get for $\$6\frac{3}{4}$?

Since $1 = \frac{4}{4}$, then $6 = \frac{24}{4}$. Hence $6\frac{3}{4} = \frac{24}{4} + \frac{3}{4}$, or $\frac{27}{4}$.

A quick way to change $6\frac{3}{4}$ to $\frac{27}{4}$ is to multiply 6 by 4 and add 3, which gives 27. Then write 27 over 4, which gives $\frac{27}{4}$.

$$6\tfrac{3}{4} = \tfrac{27}{4}$$

To reduce a mixed number to an improper fraction, multiply the whole number by the denominator, add the numerator, and place the result over the denominator.

Reduce the following to improper fractions:

1. $6\frac{1}{2}$	**4.** $5\frac{1}{6}$	**7.** $2\frac{7}{8}$	**10.** $8\frac{3}{8}$	**13.** $5\frac{2}{3}$	**16.** $8\frac{5}{16}$
2. $4\frac{2}{3}$	**5.** $9\frac{5}{6}$	**8.** $8\frac{3}{5}$	**11.** $6\frac{2}{3}$	**14.** $9\frac{5}{12}$	**17.** $2\frac{7}{10}$
3. $5\frac{1}{5}$	**6.** $7\frac{3}{7}$	**9.** $4\frac{5}{6}$	**12.** $3\frac{4}{5}$	**15.** $7\frac{3}{10}$	**18.** $2\frac{25}{100}$

19. Edith is making silk roses. If each rose takes $\frac{1}{4}$ yd. of ribbon, how many roses can she make from $2\frac{3}{4}$ yd.?

Getting Ready to Subtract Fractions

Tell what numbers should be put in place of the stars:

1. \$6 equals \$5 and 4 quarters. Then $6 = 5\frac{*}{4}$.

2. $\$6\frac{1}{4}$ equals \$5 and * quarters. Then $6\frac{1}{4} = 5\frac{*}{4}$.

3. $\$5\frac{1}{2}$ equals \$4 and * quarters. Then $5\frac{1}{2} = 4\frac{*}{4}$.

4. $\$3\frac{1}{2}$ equals \$2 and * dimes. Then $3\frac{1}{2} = 2\frac{*}{10}$.

5. $5\frac{3}{4}$ in. equals 4 in. and * eighths. Then $5\frac{3}{4} = 4\frac{*}{8}$.

6. $7 = 6\frac{*}{2}$	**10.** $7\frac{3}{4} = 6\frac{*}{4}$	**14.** $7\frac{1}{2} = 6\frac{*}{8}$
7. $8 = 7\frac{*}{4}$	**11.** $9\frac{1}{5} = 8\frac{*}{5}$	**15.** $9\frac{3}{4} = 8\frac{*}{8}$
8. $5 = 4\frac{*}{8}$	**12.** $6\frac{1}{2} = 5\frac{*}{4}$	**16.** $3\frac{1}{4} = 2\frac{*}{16}$
9. $6 = 5\frac{*}{2}$	**13.** $3\frac{1}{2} = 2\frac{*}{8}$	**17.** $2\frac{7}{8} = 1\frac{*}{16}$

TIMING THE 50-YARD DASH

1. A boy 11 yr. old should run 50 yd. in $8\frac{3}{5}$ sec. It takes Arthur $9\frac{1}{10}$ sec. What part of a second longer does Arthur take than he should?

Since $\frac{1}{10}$ is smaller than $\frac{3}{5}$, you have to change $9\frac{1}{10}$ to $8\frac{11}{10}$ before you can subtract.

The difference is $\frac{1}{2}$, hence it takes Arthur $\frac{1}{2}$ sec. longer than the time allowed.

Check the work by going over it again.

$$9\tfrac{1}{10} = 8\tfrac{11}{10}$$
$$8\tfrac{3}{5} = 8\tfrac{6}{10}$$
$$\tfrac{5}{10} = \tfrac{1}{2}$$

2. A girl 12 yr. old should run 50 yd. in 9 sec. If a boy 12 yr. old is allowed $8\frac{1}{5}$ sec., how much more time is allowed a girl than a boy to run 50 yd.?

3. An 11-year old girl is allowed $9\frac{1}{5}$ sec. for the 50-yard dash. Ruth can do it in $8\frac{7}{10}$ sec. How much less than the time allowed does it take Ruth?

Practice in Subtracting Fractions

Subtract. Check the work by going over it again:

1. $4\frac{7}{8}$	**6.** 8	**11.** $8\frac{1}{6}$	**16.** $7\frac{2}{3}$	**21.** $6\frac{1}{2}$	**26.** $9\frac{3}{4}$
$2\frac{3}{8}$	$4\frac{5}{16}$	$5\frac{5}{6}$	$5\frac{1}{6}$	$3\frac{5}{6}$	$5\frac{1}{3}$
2. $5\frac{9}{10}$	**7.** $5\frac{1}{4}$	**12.** $4\frac{3}{16}$	**17.** $8\frac{1}{2}$	**22.** $8\frac{5}{12}$	**27.** $7\frac{2}{3}$
$4\frac{3}{10}$	$2\frac{3}{4}$	$1\frac{7}{16}$	$3\frac{5}{12}$	$6\frac{5}{6}$	$6\frac{3}{5}$
3. $5\frac{15}{16}$	**8.** $9\frac{1}{8}$	**13.** $4\frac{7}{8}$	**18.** $7\frac{3}{4}$	**23.** $7\frac{1}{3}$	**28.** $8\frac{2}{3}$
$2\frac{3}{16}$	$3\frac{5}{8}$	$4\frac{1}{2}$	$2\frac{7}{16}$	$1\frac{5}{6}$	$1\frac{3}{4}$
4. 7	**9.** $4\frac{1}{3}$	**14.** $8\frac{9}{10}$	**19.** $7\frac{3}{4}$	**24.** $6\frac{1}{2}$	**29.** $8\frac{3}{8}$
$5\frac{3}{4}$	$2\frac{2}{3}$	$4\frac{2}{5}$	$2\frac{7}{8}$	$5\frac{7}{10}$	$6\frac{1}{3}$
5. 9	**10.** $9\frac{1}{10}$	**15.** $5\frac{3}{8}$	**20.** $9\frac{1}{2}$	**25.** $5\frac{1}{2}$	**30.** $9\frac{3}{4}$
$4\frac{7}{8}$	$7\frac{7}{10}$	$3\frac{3}{16}$	$5\frac{15}{16}$	$4\frac{1}{3}$	$6\frac{2}{3}$

IMPROVEMENT TEST No. 14

Test 14 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.
962	745	821	630	514
257	984	353	231	895
326	623	844	751	356
837	435	430	939	583
942	992	248	927	767
707	159	818	535	382
655	750	887	161	386
195	767	681	168	462
900	398	567	729	107
618	123	344	747	136

Test 14 B — Subtraction (Time 4 min.)

1.	2.	3.	4.
745091	807842	609356	958300
480812	552085	234696	763970

5.	6.	7.	8.
977319	623525	924414	900000
679071	130257	380457	215309

9.	10.	11.	12.
664176	737811	615643	500003
372229	390244	478055	386418

Test 14 C — Multiplication (Time 4 min. after copying)

1.	2.	3.	4.	5.
483	418	576	863	475
928	763	725	518	438

Test 14 D — Division (Time 4 min. after copying)

1. $173\overline{)44807}$ 2. $748\overline{)433840}$ 3. $688\overline{)567945}$

USING FRACTIONS IN PROBLEMS

1. A party of girl scouts are hiking to a village 14 mi. away. When they have walked $7\frac{1}{4}$ mi., how many miles have they still to walk?

2. Amy's scout troop is hiking from Hightown to Cobham, a distance of $12\frac{1}{4}$ mi. At Glenville they see a sign, "To Cobham, $4\frac{1}{2}$ mi." How much of the distance have they covered by that time?

3. Olive and Cora hike $4\frac{3}{4}$ mi. to Blue River. They walk $1\frac{5}{8}$ mi. along the river and then reach home by walking $5\frac{1}{2}$ mi. along the road. How many miles in all do they hike?

4. May weighs 85 lb. Her baby sister weighs $16\frac{3}{16}$ lb. How much more does May weigh than the baby?

5. On a 5-hour automobile trip with his father, Dan kept count of the number of miles they drove each hour. His record was as follows: $23\frac{1}{2}$ mi., $21\frac{9}{10}$ mi., 25 mi., $26\frac{4}{5}$ mi., and $23\frac{7}{10}$ mi. How many miles did they drive?

6. John's father is $6\frac{1}{4}$ ft. tall, while John is $4\frac{2}{3}$ ft. tall. How much shorter is John than his father?

7. Hugh keeps chickens. On Monday he collected $2\frac{5}{12}$ doz. eggs; on Tuesday, $3\frac{1}{4}$ doz.; and on Wednesday, $3\frac{1}{2}$ doz. How many dozen eggs did he collect in all?

USING FRACTIONS IN THE STORE

1. Bert works in a store. When he sells anything he makes out a *sales slip* like the one shown below. On this slip "$\frac{3}{4}$ lb. butter @ .48" means that the butter costs 48¢ a pound. What does the 36 stand for?

In finding $\frac{3}{4}$ of 48¢, Bert does the work in his head, like this: $\frac{1}{4}$ of 48 = 12; hence $\frac{3}{4}$ of 48 = 3 × 12, or 36.

In finding $\frac{3}{4}$ of 51¢, however, Bert cannot do the work mentally because 51¢ is not exactly divisible by 4. Hence he first multiplies 51 by 3 and then divides the result by 4, thus:

$$\frac{3}{4}\times 51=\frac{3\times 51}{4}=\frac{153}{4}=38\tfrac{1}{4}$$

The answer is $38\frac{1}{4}$¢, which Bert calls 39¢.

THE ECONOMY MARKET

Date Jan. 3 19~

Sold by #15 Am't. Rec'd $5.00

$\frac{3}{4}$ lb. butter @ .48		36
$\frac{3}{4}$ lb. coffee @ .51		39
$2\frac{1}{2}$ lb. prunes @ .17		43
$2\frac{1}{2}$ doz. eggs @ .65	1	63
	2	81

In retail stores a fraction of a cent is usually counted as another cent.

2. When you find $\frac{3}{4}$ of 24¢, you are multiplying 24 by $\frac{3}{4}$ and you may write it like this: $\frac{3}{4} \times 24$. The sign × means " of " when written after a fraction.

3. Multiply a whole number by a fraction in this way:

If the whole number is exactly divisible by the denominator, first divide by the denominator and then multiply by the numerator. Otherwise first multiply by the numerator and then divide by the denominator.

By this rule you always multiply by the numerator and divide by the denominator. In certain cases you *divide first* and then multiply, while in other cases you *multiply first* and then divide.

MAKING OUT SALES SLIPS

Make out sales slips for the following and add each:

1. $\frac{3}{4}$ lb. Swiss cheese @ 60¢
$\frac{3}{8}$ lb. tea @ 64¢
$2\frac{1}{2}$ lb. butter @ 56¢

2. $1\frac{1}{2}$ doz. rolls @ 15¢
$\frac{2}{3}$ doz. sweet buns @ 25¢
$2\frac{3}{4}$ doz. cookies @ 18¢
1 loaf of bread @ 9¢

3. $2\frac{3}{4}$ lb. lamb chops @ 48¢
$2\frac{7}{8}$ lb. bacon @ 40¢
$6\frac{1}{4}$ lb. chicken @ 50¢

4. $\frac{5}{8}$ lb. cheese @ 30¢
$\frac{1}{4}$ lb. tea @ 70¢
$\frac{3}{4}$ lb. butter @ 50¢
$\frac{3}{4}$ doz. candles @ 65¢

5. Make out the sales slip that Rose receives when she buys: $3\frac{1}{2}$ yd. of gingham @ 59¢, $4\frac{3}{4}$ yd. of ribbon @ 22¢, $\frac{7}{8}$ yd. of velvet @ \$2.50, and 3 cards of buttons @ 15¢.

6. Mary bought $2\frac{1}{2}$ yd. of cotton crêpe @ 75¢, $\frac{3}{4}$ yd. of organdie @ 89¢, $\frac{1}{2}$ doz. buttons @ 28¢, and 2 spools of thread @ 10¢. Make out the sales slip.

Practice in Multiplying by a Fraction

Multiply the following mentally:

1. $\frac{3}{4}$ of 28
2. $\frac{2}{3}$ of 18
3. $\frac{7}{8}$ of 16
4. $\frac{2}{3}\times 45$
5. $\frac{3}{5}\times 35$
6. $\frac{5}{6}\times 30$
7. $\frac{5}{8}\times 40$
8. $\frac{3}{4}\times 160$
9. $\frac{3}{10}\times 150$

Multiply. Call a fraction of a cent another cent:

10. $\frac{3}{5}$ of \$.12
11. $\frac{2}{3}$ of \$.80
12. $\frac{3}{4}$ of \$.35
13. $\frac{5}{8}$ of \$.50
14. $\frac{7}{8}$ of \$.20
15. $\frac{4}{5}$ of \$.28
16. $1\frac{5}{6}\times$ \$.40
17. $5\frac{3}{4}\times$ \$.25
18. $2\frac{3}{8}\times$ \$.30
19. $2\frac{2}{3}\times$ \$.96
20. $6\frac{7}{8}\times$ \$.45
21. $6\frac{5}{8}\times$ \$.65
22. $3\frac{3}{8}\times$ \$.60
23. $5\frac{3}{4}\times$ \$.44
24. $2\frac{2}{3}\times$ \$.30
25. $8\frac{5}{12}\times$ \$.36
26. $7\frac{5}{12}\times$ \$.60
27. $9\frac{3}{16}\times$ \$.20

MULTIPLYING FRACTIONS BY WHOLE NUMBERS

1. How high is a pile of 9 boards if each is $\frac{5}{8}$ in. thick?

You know that 9×5 *books* $= 45$ *books*. In the same way, 9×5 *eighths* $= 45$ *eighths*, or $5\frac{5}{8}$, as shown at the right.

$$9 \times \frac{5}{8} = \frac{9 \times 5}{8} = \frac{45}{8} = 5\frac{5}{8}$$

To multiply a fraction by a whole number, multiply the numerator by the whole number and divide the result by the denominator.

Explain each step in the following problems:

2. Multiply $\frac{7}{8}$ by 12.

$$12 \times \frac{7}{8} = \frac{\overset{3}{\cancel{12}} \times 7}{\underset{2}{\cancel{8}}} = \frac{21}{2} = 10\frac{1}{2}$$

3. Multiply $18\frac{3}{4}$ by 7.

$$\begin{array}{r} 18\frac{3}{4} \\ 7 \\ \hline 5\frac{1}{4} \\ 126 \\ \hline 131\frac{1}{4} \end{array}$$

Exercises

1. It is $\frac{3}{4}$ mi. around a running track. How far does Bert run if he goes around the track 5 times?

Multiply mentally. Reduce the result, if possible:

2. $5 \times \frac{3}{8}$	**5.** $6 \times \frac{2}{5}$	**8.** $7 \times \frac{4}{5}$	**11.** $9 \times \frac{2}{3}$
3. $8 \times \frac{1}{2}$	**6.** $4 \times \frac{2}{3}$	**9.** $2 \times \frac{5}{8}$	**12.** $3 \times \frac{3}{5}$
4. $3 \times \frac{3}{8}$	**7.** $6 \times \frac{2}{3}$	**10.** $3 \times \frac{5}{8}$	**13.** $6 \times \frac{1}{6}$

Multiply the following. Cancel when possible:

14. $8 \times \frac{5}{16}$	**16.** $48 \times \frac{7}{12}$	**18.** $5 \times \frac{7}{10}$	**20.** $24 \times \frac{5}{6}$
15. $8 \times \frac{3}{4}$	**17.** $25 \times \frac{9}{10}$	**19.** $6 \times \frac{5}{12}$	**21.** $36 \times \frac{7}{8}$

Multiply the following mixed numbers:

22. $12 \times 6\frac{1}{2}$	**24.** $15 \times 16\frac{2}{3}$	**26.** $9 \times 12\frac{5}{6}$
23. $6 \times 33\frac{1}{3}$	**25.** $15 \times 37\frac{1}{2}$	**27.** $16 \times 35\frac{7}{12}$

MULTIPLYING A FRACTION BY A FRACTION

Review this rule, which you learned on page 92:

To multiply a fraction by a fraction, multiply the numerators together for a new numerator and the denominators together for a new denominator.

This rule may also be used to multiply mixed numbers if each mixed number is first reduced to an improper fraction.

Study the steps in working these problems:

1. Multiply $\frac{4}{9}$ by $\frac{1}{8}$.

$$\frac{1}{\cancel{8}_{2}} \times \frac{\cancel{4}^{1}}{9} = \frac{1 \times 1}{2 \times 9} = \frac{1}{18}$$

First cancel 4 from 8 and from 4, thinking "$8 \div 4 = 2$ and $4 \div 4 = 1$." Notice that the numerator of the result is 1×1, which equals 1.

2. Multiply $5\frac{5}{8}$ by $3\frac{1}{5}$.

$$\frac{\cancel{16}^{2}}{\cancel{5}_{1}} \times \frac{\cancel{45}^{9}}{\cancel{8}_{1}} = \frac{2 \times 9}{1 \times 1} = 18$$

Change $3\frac{1}{5}$ to $\frac{16}{5}$ and $5\frac{5}{8}$ to $\frac{45}{8}$. Cancel 5, thinking "$5 \div 5 = 1$ and $45 \div 5 = 9$." Then cancel 8, thinking "$8 \div 8 = 1$ and $16 \div 8 = 2$."

3. In ex. 1 above you could have done the work without canceling, thus: $\frac{1}{8} \times \frac{4}{9} = \frac{4}{72}$. Then you would have had to reduce $\frac{4}{72}$ to $\frac{1}{18}$, which is the same result you got above. By canceling you were saved the trouble of reducing the result to lowest terms.

When you cancel in multiplying fractions, you divide a numerator and a denominator by the same number.

Exercises

1. In copying a scout map John wishes to make each line $\frac{7}{10}$ as long as it is on the original map. How long should he make a line that is $\frac{15}{16}$ in. on the original map?

2. A cake recipe calls for $2\frac{2}{3}$ cups of sugar. How much sugar is needed for $1\frac{1}{4}$ times the recipe?

GRADED EXERCISES

Multiply. Check the work by going over it again:

Group			
A.	1. $\frac{3}{4}\times\frac{1}{4}$	2. $4\frac{2}{3}\times\frac{2}{3}$	3. $2\frac{1}{2}\times3\frac{1}{2}$
	4. $\frac{3}{8}\times\frac{3}{4}$	5. $4\frac{1}{3}\times2\frac{1}{2}$	6. $2\frac{1}{5}\times1\frac{1}{3}$
B.	7. $\frac{4}{5}\times1\frac{1}{2}$	8. $12\frac{1}{2}\times\frac{3}{5}$	9. $3\frac{1}{8}\times3\frac{2}{5}$
	10. $\frac{7}{12}\times4\frac{4}{5}$	11. $5\frac{3}{4}\times5\frac{3}{5}$	12. $2\frac{1}{2}\times2\frac{2}{3}$
C.	13. $\frac{5}{9}\times\frac{3}{4}$	14. $4\frac{1}{10}\times\frac{5}{6}$	15. $1\frac{1}{5}\times1\frac{7}{12}$
	16. $\frac{3}{10}\times\frac{5}{8}$	17. $\frac{4}{5}\times\frac{7}{8}$	18. $2\frac{1}{2}\times1\frac{3}{10}$
D.	19. $\frac{5}{9}\times7\frac{1}{2}$	20. $7\frac{1}{2}\times\frac{3}{10}$	21. $\frac{7}{8}\times2\frac{2}{5}$
	22. $\frac{9}{10}\times\frac{15}{16}$	23. $7\frac{1}{2}\times4\frac{3}{10}$	24. $5\frac{3}{5}\times1\frac{5}{12}$
E.	25. $\frac{1}{2}\times\frac{8}{9}$	26. $\frac{1}{8}\times13\frac{1}{3}$	27. $6\frac{2}{5}\times\frac{1}{8}$
	28. $\frac{1}{7}\times\frac{14}{15}$	29. $\frac{1}{6}\times2\frac{2}{5}$	30. $1\frac{1}{5}\times\frac{1}{2}$
F.	31. $\frac{1}{5}\times\frac{5}{6}$	32. $\frac{1}{8}\times1\frac{1}{3}$	33. $1\frac{3}{5}\times\frac{1}{16}$
	34. $\frac{1}{10}\times1\frac{1}{9}$	35. $2\frac{1}{2}\times\frac{1}{15}$	36. $3\frac{1}{5}\times\frac{1}{16}$
G.	37. $\frac{4}{9}\times18$	38. $\frac{5}{6}\times24$	39. $15\times\frac{3}{5}$
	40. $\frac{3}{5}\times25$	41. $\frac{5}{6}\times72$	42. $88\times\frac{7}{8}$
H.	43. $\frac{2}{5}\times\frac{15}{16}$	44. $3\frac{3}{4}\times\frac{2}{3}$	45. $2\frac{5}{8}\times1\frac{1}{3}$
J.	46. $\frac{8}{9}\times\frac{3}{8}$	47. $2\frac{2}{3}\times\frac{3}{16}$	48. $1\frac{1}{4}\times\frac{4}{15}$
K.	49. $5\frac{5}{8}\times3\frac{1}{5}$	50. $2\frac{2}{5}\times\frac{5}{6}$	51. $\frac{3}{5}\times3\frac{1}{3}$
L.	52. $\frac{9}{10}\times9\frac{1}{6}$	53. $3\frac{3}{10}\times4\frac{1}{6}$	54. $14\frac{2}{5}\times\frac{5}{16}$

Note. Each of the above groups represents a different difficulty.

DIVIDING FRACTIONS

1. In the division of fractions you must always *invert* the divisor. To invert means *to turn upside down.* Thus, $\frac{2}{3}$ inverted is $\frac{3}{2}$, while $\frac{5}{9}$ inverted is $\frac{9}{5}$. You may also *invert* a whole number. For example, to invert 3 (which equals $\frac{3}{1}$) you write it as $\frac{1}{3}$. If you invert $\frac{1}{9}$, you get $\frac{9}{1}$, or 9.

You have already learned the following rule:

To divide a fraction by a fraction, invert the divisor and multiply.

This rule may also be used for dividing mixed numbers or for dividing by a whole number. Be sure always to invert the divisor before multiplying.

2. A fast airplane flying at the rate of $2\frac{1}{2}$ mi. a minute will take how many minutes to travel 75 mi.?

You must divide 75 by $2\frac{1}{2}$. First change $2\frac{1}{2}$ to $\frac{5}{2}$. Next invert $\frac{5}{2}$ to $\frac{2}{5}$. Then multiply as shown here.

$$75 \div \frac{5}{2} = 75 \times \frac{2}{5} = \frac{\overset{15}{\cancel{75}} \times 2}{\underset{1}{\cancel{5}}} = 30$$

To check, go over the work or multiply 30 by $2\frac{1}{2}$, which gives 75.

3. In 3 yr. Lena gained $28\frac{1}{2}$ lb. in weight. Find her average gain each year.

You must divide $28\frac{1}{2}$ by 3. First change $28\frac{1}{2}$ to $\frac{57}{2}$. Since 3 is the divisor, invert it to $\frac{1}{3}$ and multiply as shown here.

$$\frac{57}{2} \div 3 = \frac{\overset{19}{\cancel{57}}}{2} \times \frac{1}{\underset{1}{\cancel{3}}} = \frac{19}{2} = 9\frac{1}{2}$$

You can prove that $9\frac{1}{2}$ is the correct result because $3 \times 9\frac{1}{2} = 28\frac{1}{2}$.

4. Mr. King's car travels 15 mi. on 1 gal. of gasoline. How many gallons will he use on a trip of $67\frac{1}{2}$ mi.?

5. Mrs. Lee bought $3\frac{1}{2}$ yd. of curtain goods. How many curtains, each $\frac{7}{8}$ yd. long, can she make from this?

GRADED EXERCISES

Divide. Check the work by going over it again:

GROUP do more if can

A.	**1.** $\frac{1}{2} \div \frac{1}{3}$	**2.** $\frac{2}{5} \div \frac{1}{3}$	**3.** $\frac{2}{3} \div 3$
	4. $\frac{3}{8} \div 2$	**5.** $\frac{4}{5} \div 3$	**6.** $\frac{15}{16} \div 2$
	7. $\frac{3}{4} \div 2$	**8.** $\frac{5}{6} \div 2$	**9.** $3\frac{1}{2} \div 1\frac{2}{3}$
B.	**10.** $\frac{7}{8} \div \frac{3}{16}$	**11.** $\frac{3}{8} \div \frac{5}{16}$	**12.** $2\frac{4}{5} \div \frac{2}{3}$
C.	**13.** $\frac{2}{3} \div \frac{4}{5}$	**14.** $\frac{5}{6} \div \frac{2}{3}$	**15.** $\frac{11}{12} \div \frac{5}{6}$
D.	**16.** $\frac{6}{5} \div 9$	**17.** $\frac{9}{16} \div 1\frac{1}{5}$	**18.** $7\frac{1}{5} \div 24$
	19. $\frac{4}{5} \div 6$	**20.** $7\frac{1}{2} \div 3\frac{1}{3}$	**21.** $3\frac{3}{5} \div 27$
	22. $\frac{13}{16} \div \frac{5}{24}$	**23.** $2\frac{1}{4} \div 12$	**24.** $12\frac{3}{5} \div 18$
	25. $\frac{15}{16} \div 12$	**26.** $2\frac{2}{5} \div 16$	**27.** $11\frac{1}{4} \div 20$
E.	**28.** $\frac{3}{8} \div \frac{1}{4}$	**29.** $8 \div 3\frac{1}{5}$	**30.** $\frac{15}{16} \div 5$
	31. $\frac{8}{9} \div 2$	**32.** $8\frac{1}{3} \div 5$	**33.** $5 \div 7\frac{1}{2}$
	34. $\frac{9}{16} \div 3$	**35.** $5\frac{2}{5} \div 9$	**36.** $14\frac{2}{5} \div 12$
F.	**37.** $\frac{1}{10} \div \frac{4}{5}$	**38.** $\frac{1}{8} \div 1\frac{7}{8}$	**39.** $\frac{5}{8} \div 10$
	40. $\frac{2}{3} \div 8$	**41.** $1\frac{1}{3} \div 16$	**42.** $\frac{1}{3} \div 3\frac{1}{3}$
	43. $\frac{5}{6} \div 10$	**44.** $1\frac{3}{4} \div 14$	**45.** $2\frac{1}{2} \div 25$
G.	**46.** $\frac{7}{8} \div \frac{1}{16}$	**47.** $16 \div 2\frac{2}{3}$	**48.** $27 \div \frac{3}{8}$
H.	**49.** $\frac{3}{8} \div \frac{9}{16}$	**50.** $12\frac{1}{2} \div 9\frac{3}{8}$	**51.** $2\frac{1}{4} \div 3\frac{3}{8}$
J.	**52.** $\frac{5}{16} \div \frac{5}{8}$	**53.** $\frac{4}{5} \div 1\frac{3}{5}$	**54.** $2\frac{2}{3} \div 13\frac{1}{3}$
K.	**55.** $\frac{3}{4} \div \frac{3}{16}$	**56.** $4\frac{2}{3} \div 1\frac{5}{9}$	**57.** $12\frac{1}{2} \div \frac{5}{8}$
L.	**58.** $\frac{5}{16} \div \frac{5}{6}$	**59.** $3\frac{3}{5} \div 2\frac{1}{10}$	**60.** $1\frac{15}{16} \div 1\frac{1}{24}$

NOTE. The above groups are similar to those on pages 116 and 118.

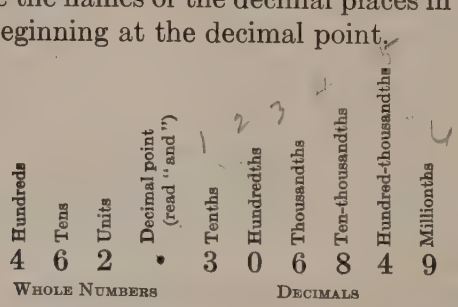
DECIMALS

Reading and Writing Decimals

A **decimal** is a short way of writing a fraction like $\frac{7}{10}$ or $\frac{15}{100}$ without writing the denominator. Thus, .7 means $\frac{7}{10}$ and is read *7 tenths*. .15 means $\frac{15}{100}$ and is read *15 hundredths*. .165 means $\frac{165}{1000}$ and is read *165 thousandths*. .6 is called a 1-place decimal; .24 is a 2-place decimal; and .236 is a 3-place decimal.

There are also decimals of four, five, and six places. Thus, .1029 = $\frac{1029}{10000}$ and is read *1029 ten-thousandths*. .178407 = $\frac{178407}{1000000}$ and is read *178,407 millionths*. To read a decimal, read it as a whole number and then give it the name of its last decimal place.

Memorize the names of the decimal places in the following chart, beginning at the decimal point.



The number 462.306849 is a **mixed decimal**; it is made up of a whole number and a decimal. Read it *462 and 306,849 millionths*, reading *and* at the decimal point.

In reading dollars and cents, however, the word *and* is often omitted. Thus, \$2.46 may be read *2 dollars, 46 cents*.

In business, a number like 5.628 may be read *five-point-six-two-eight*. How is the decimal point read here?

READING DECIMALS

A zero may be placed before a decimal like .3 to call attention to the decimal point. Thus, 0.3 means .3.

Read these decimals:

1.	.7	0.9	.235	0.9160	.01032
2.	.08	0.08	.050	0.0003	.00008

Read each of these in two different ways:

3.	9.704	6.0085	29.23730	7.008975
4.	5.007	3.9816	30.05068	8.000001

How the Position of a Figure Affects Its Value

1. In the numbers at the right, the value of the 3 depends on its position in the number. Each time the 3 is moved 1 place to the left, its value becomes 10 times as great as before.

In 263 the 3 represents 3
In 237 the 3 represents 30
In 325 the 3 represents 300

2. Now study these decimals. Does the value of the 3 here also depend on its position? Since $10 \times .003 = .03$ and $10 \times .03 = .3$, you see that each time the 3 is moved 1 decimal place to the left, its value is multiplied by 10.

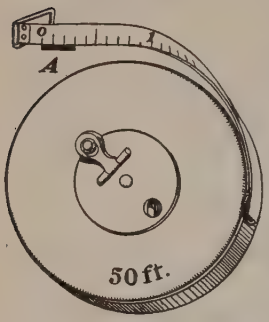
In .513 the 3 represents .003
In .431 the 3 represents .03
In .348 the 3 represents .3

If any figure of a number is moved 1 *place to the left, its value becomes* 10 *times as great as before.*

3. Write these numbers under one another in the order of their value. Keep the decimal points in line.

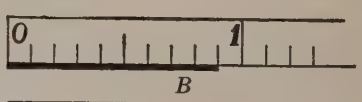
700 .7 .07 70 .007 7 .0007 7000

HOW FRANK'S FATHER MEASURES LAND

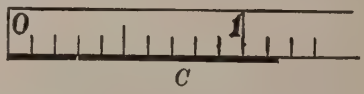


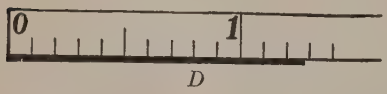
Frank's father is a surveyor who measures land. He has a steel tape on which each foot is divided into 100 equal parts. Hence each part is $\frac{1}{100}$ of a foot, or .01 ft., long. The shaded line A in the picture, which covers 3 small spaces, represents $\frac{3}{100}$ ft., or .03 ft. The length from 0 to 1, which covers 10 small spaces, represents .10 ft., or .1 ft. Hence the number 1 on the tape stands for .1 ft. and the number 2 stands for .2 ft., or .20 ft.

1. How many hundredths of a foot long is shaded line B?



Line C is a little longer than .11 ft. Measured to the *nearest hundredth* of a foot, we say that C is .11 ft. long because its length is nearer to .11 than to .12.





2. Is the shaded line D closer to .13 or to .12? Then how long is D, to the *nearest hundredth* of a foot?

3. If you measure only to the *nearest tenth* of a foot, line B is .1 ft. long. How long is line C, to the nearest tenth of a foot? How long is line D?

4. Express the following lengths to the nearest tenth of a foot: 5.29 ft., 7.21 ft., 4.38 ft., 6.42 ft.

MEASURING TO HUNDREDTHS OF A FOOT

It is very hard to measure accurately. If you measure land with a long tape, stretching the tape tightly, you may get a length of 86.23 ft. But if you let the tape sag a little, the length may be 86.29 ft. or even 86.32 ft. Land is measured to the *nearest hundredth* of a foot, if it is very valuable; otherwise it is measured to the *nearest tenth* of a foot or to the *nearest foot.*

It is very convenient to measure lengths to tenths and hundredths of a foot. Mary's height, measured in feet and inches, might be 5 ft. $3\frac{1}{2}$ in.; but with the foot divided into hundredths, it would be 5.29 ft. Which is shorter to write, 5.29 ft. or 5 ft. $3\frac{1}{2}$ in.?

Exercises

1. To express 8.48 ft. to the nearest tenth of a foot, Ada thinks "8.48 is nearer to 8.50 than to 8.40; hence 8.48 ft., to the nearest tenth, is 8.5 ft." Is Ada right?

2. Give each of these lengths to the nearest tenth of a foot: 7.32 ft., 8.29 ft., 3.17 ft., 4.12 ft., 5.09 ft., 3.01 ft

3. Make a ruler of cardboard with the foot marked into tenths and hundredths. To do this, place the edge of the cardboard along the line at *C* on page 216 to get the right length for each space.

4. Find the length of your classroom, to the nearest tenth of a foot; to the nearest whole foot.

Measure the following to the nearest tenth of a foot; also measure each to the nearest hundredth of a foot:

5. The height of each pupil in your class.

6. The length and the width of your desk; of the door.

WHAT IS WRONG WITH THESE STATEMENTS?

Some of the numbers below need decimal points to make the statements sensible. Put the decimal points where they belong in the numbers that need them.

1. Kenneth is 11 yr. old and weighs 875 pounds.
2. Alice sold her ice skates to Jenny for $200.
3. A fast airplane traveled 135 mi. an hour.
4. John can run 50 yd. in 83 sec.
5. Mary is 10 yr. old and is 49 ft. tall.
6. Dick paid $25 for a bag of 10 marbles.
7. The flagpole in the school yard is 30 ft. high.
8. Mrs. Jones paid $48 a pound for a turkey.
9. Mr. Smith drives his car 216 mi. an hour.
10. Henry's mother bought him a suit for $1875 and a pair of tennis shoes for $139.
11. Tom is 12 yr. old and is 585 in. tall.

The decimal points below are in the wrong places. Put them where they belong to make the statements sensible.

12. Sam can walk a mile in 2.3 min.
13. Will rides his bicycle .93 mi. an hour.
14. Mr. James bought a new automobile for $12.35.
15. Nat is 11 yr. old and weighs 9.2 lb.
16. Arthur was paid $2.5 an hour for running errands.
17. A fast train traveled 4.8 mi. per hour.
18. Edward paid $.01 for a circus ticket.
19. Janet paid $.065 a quart for ice cream.
20. Grace received $8.50 change from a dollar bill.

CHANGING THE NAME OF A DECIMAL

Every decimal has the same name as its *understood* denominator. Thus, every 2-place decimal, like .45, has the name *hundredths*, while every 3-place decimal, like .162, has the name *thousandths*. A decimal has the same name as its last decimal place. It is often convenient to change a decimal to one with a different name.

You can change the name of a decimal without changing its value by annexing or removing zeros at the right of it.

Thus, $.4 = .40$, or $.400$, because $\frac{4}{10} = \frac{40}{100} = \frac{400}{1000}$.

Also, $.530 = .53$ because $\frac{530}{1000} = \frac{53}{100}$.

If two decimals have different names, you can change them to decimals with the same name by annexing zeros at the right of one of them. Thus, .23 and .465 have different names; but if you change .23 to .230, you see that .230 and .465 now have the same name.

Exercises

1. *Change to hundredths:* .1 .7 .3 .8 .2 .5

2. *Change to thousandths:* .9 .6 .43 .50 .05 .80

3. *Change to hundredths:* .810 .700 .980 .300 .050

4. *Change to tenths:* .90 .80 .600 .500 .40

In each of the following, pick out all the tenths, then all the hundredths, then all the thousandths:

5. .14 .030 .7 .008 .050 .05

6. .9 .17 .60 .5 .130 .3

In each example, give both decimals the same name:

7. .21 and .209 **9.** .81 and .9 **11.** .02 and .018

8. .85 and .868 **10.** .64 and .037 **12.** .05 and .3185

COMPARING DECIMALS

In a race, an American airplane averaged 149.6 mi. an hour, while a French airplane averaged 149.57 mi. an hour. Which airplane went faster?

You have learned that you cannot compare 3 ft. and 37 in. unless you first give them the same name. If you change 3 ft. to 36 in., can you tell easily whether 36 in. or 37 in. is larger?

Likewise, in the above problem, you cannot compare the decimals .6 and .57 because they have different names. But if you change .6 to .60, so that both decimals have the name *hundredths*, you can easily compare .60 and .57. Since .60 is greater than .57, you see at once that .6 is greater than .57.

Hence the American airplane flew faster.

To compare two decimals, give them the same name by annexing zeros at the right of one of the decimals.

Exercises

In each problem, tell which decimal is larger:

1. .4 or .36	**5.** .89 or .900	**9.** .28 or .2652
2. .6 or .60	**6.** .45 or .448	**10.** .030 or .0281
3. .8 or .82	**7.** .27 or .273	**11.** .003 or .0028
4. .1 or .09	**8.** .02 or .009	**12.** .201 or .2009

13. James lives 1.3 mi. from school. Arthur lives 1.25 mi. from school. Who lives farther away?

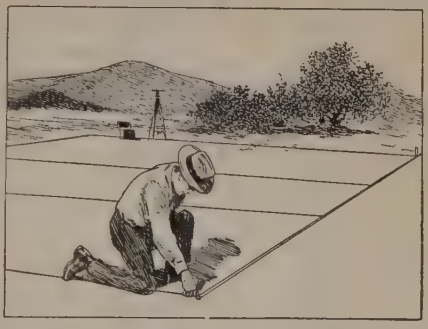
14. Fred found that his plot in the school garden was 14.8 ft. long. Is this more or less than $14\frac{3}{4}$ ft.?

15. Express these decimals as thousandths and arrange them in the order of their size, with the largest on top:

.61 .8 .295 .791 .78 .82 .7

MEASURING VALUABLE LAND

A surveyor near our house measured three valuable lots that were side by side. The first lot measured 35.78 ft. in width; the second measured exactly 25 ft.; and the third measured exactly 25.3 ft. How wide were the three lots together?



Since the land was valuable, each lot was measured to the *nearest hundredth* of a foot. Thus, the first lot was 35.78 ft. wide. In saying that the second lot was exactly 25 ft. wide, the surveyor meant 25.00 ft.; likewise, by "exactly 25.3 ft.," he meant 25.30 ft.

You could add the decimals as in *A*, but it is easier to keep them in the correct columns if you annex zeros, as in *B*. *B* shows also, without further explanation, that all the measurements were made to the nearest hundredth of a foot, which it is important for us to know.

A	*B*
35.78	35.78
25.	25.00
25.3	25.30
86.08	86.08

The width of the three lots was 86.08 ft.

If the land were less valuable, it would be measured to the *nearest tenth* of a foot and the numbers would be written as in *C*. Still less valuable land is measured to the *nearest whole foot* and the results are written as in *D*.

C	*D*
35.8	36
25.0	25
25.3	25
86.1	86

When several similar things are measured, each measurement is made to the same number of decimal places; that is, each is made to tenths or each to hundredths or each to thousandths.

GRADED EXERCISES IN ADDING DECIMALS

Add the following and check the work:

1.
6.67
5.74
.45
8.36

2.
8.698
.845
8.050
5.333

3.
7.0625
7.9995
.8478
4.1607

4.
5.05625
4.37075
.56699
2.68527

5.
6.02
7.89
8.52
1.10
.12
4.73
2.89

6.
5.666
.711
9.375
7.166
1.426
.150
8.719

7.
3.9668
1.4400
2.3842
.0434
.7313
.8835
.2575

8.
2.00975
.57775
1.00001
7.43920
3.43456
.30299
2.11223

9.
6.28
3.2
.88
9.4

10.
3.02
9.875
5.8
7.333

11.
9.166
6.2
1.75
4.

12.
5.05
6.004
.56751
9.88272

Copy in columns and add. Then annex zeros to give each decimal the same number of places and add again. Do you get the same answer both ways?

13. 41.3, 56.98, 5.16, 2.333, 82.05

14. 23.006, 19, 4.28, 1.09, 5.4

15. 6.4, 2.07, 65, 9.555, 4.375

16. 18.05, .033, .75, 9.685, 21.5

17. 2.075, 13.95, 4.375, 5.0005

18. 9.5, 14, 24.65, .0525, 9.533

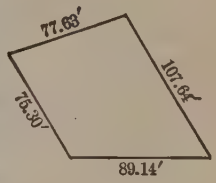
19. 3.0005, 98.125, 4.333, .127

20. 9.8333, 4.17, 9.005, 98, 56.2505

PROBLEMS

1. Last week Dick rode his new bicycle 16.4 mi. on Monday, 9.8 mi. on Tuesday, 11.5 mi. on Wednesday, 13 mi. on Thursday, and 17.2 mi. on Saturday. How many miles did he ride last week?

2. The lengths of the four sides of a lot are 77.63 ft., 107.64 ft., 89.14 ft., and 75.30 ft. Find the distance around the lot. This distance is called the *perimeter*.



3. On modern dairy farms milk is often weighed to tenths of a pound. In one week a prize cow gave these amounts of milk: 49.3 lb., 47.6 lb., 51.2 lb., 52.3 lb., 46.5 lb., 45.2 lb., and 48.2 lb. Find the total number of pounds for the week.

4. Three iron rods have these lengths: 25.753 ft., 18.654 ft., and 17.740 ft. If the rods are laid end to end in a straight line, what distance will they cover?

5. Sam ran 100 yd. each of 6 days. His records were 15.1 sec., 15.6 sec., 15.5 sec., 14.9 sec., 15.3 sec., and 14.8 sec. Find his average time for 100 yd.

6. Mr. Fox found that five very thin sheets of metal measured in thickness .0052 in., .0183 in., .0091 in., .0112 in., and .0060 in. How thick were the five sheets together?

7. The teacher asked Lucy to tell some uses of decimals in measuring. Lucy said that surveyors measure to tenths and hundredths of a foot, rain is measured to hundredths of an inch, stop watches measure time to tenths of a second, and speedometers measure distances to tenths of a mile. What other uses can you think of?

CHANGING DECIMALS TO COMMON FRACTIONS

The Weather Bureau reported that .75 in. of rain fell yesterday in Bedford. Write .75 in. another way.

Since $.75 = \frac{75}{100} = \frac{3}{4}$, you see that .75 in. is equal to $\frac{3}{4}$ in.
In the same way, 6.75 may be written as $6\frac{3}{4}$.

To change a decimal to a common fraction, omit the decimal point and write the decimal over its understood denominator. Then reduce the fraction to lowest terms.

Thus, $.375 = \frac{375}{1000} = \frac{3}{8}$ and $.33\frac{1}{3} = \frac{33\frac{1}{3}}{100} = \frac{33\frac{1}{3} \times 3}{100 \times 3} = \frac{1}{3}$.

The number of zeros in the understood denominator is the same as the number of places in the decimal. Since .625 has 3 decimal places, its understood denominator has 3 zeros and $.625 = \frac{625}{1000}$.

Change to common fractions or to mixed numbers:

1.	.25	.50	$.16\frac{2}{3}$	6.50	$1.37\frac{1}{2}$
2.	.65	$.62\frac{1}{2}$	$.87\frac{1}{2}$	.800	$8.62\frac{1}{2}$
3.	.80	$.83\frac{1}{3}$	$.66\frac{2}{3}$	.025	$3.12\frac{1}{2}$

Frequently Used Decimals

Memorize the following because they are often used:

$.25 = \frac{1}{4}$	$.12\frac{1}{2} = \frac{1}{8}$	$.33\frac{1}{3} = \frac{1}{3}$
$.50 = \frac{1}{2}$	$.37\frac{1}{2} = \frac{3}{8}$	$.66\frac{2}{3} = \frac{2}{3}$
$.75 = \frac{3}{4}$	$.62\frac{1}{2} = \frac{5}{8}$	$.16\frac{2}{3} = \frac{1}{6}$
$1.00 = 1$	$.87\frac{1}{2} = \frac{7}{8}$	$.83\frac{1}{3} = \frac{5}{6}$

Change mentally to fractions or to mixed numbers:

1.	.25	1.75	$.16\frac{2}{3}$	$6.87\frac{1}{2}$	$2.66\frac{2}{3}$
2.	$.62\frac{1}{2}$	3.50	$.37\frac{1}{2}$	$1.33\frac{1}{3}$	$5.12\frac{1}{2}$

USING DECIMALS

1. Mr. Smith drives his car 22.8 mi. an hour. If the speed limit is 25 mi. an hour, how much faster could he drive and still keep within the limit?

$$\begin{array}{r} 25.0 \\ 22.8 \\ \hline 2.2 \end{array}$$

First write 25 as 25.0 and then subtract.
Check by seeing whether $2.2 + 22.8 = 25$.

2. Last year Alice could swim the length of the 60-foot pool in 41.3 sec. Now she does it in 39.9 sec. By how much has she lowered her time?

3. The speedometer on Mr. Hart's car read 987.6 mi. on Sunday and 1177.5 mi. at the end of the week. How many miles did he drive that week?

4. When the English unit of money, the pound, is worth \$4.8665, how much less than \$5 is it worth?

5. A surveyor found a bridge 27.325 ft. high at one end and 29.002 ft. high in the middle. How much higher was the middle of the bridge than the end?

6. Raymond found that the water in a pan was 2.7 in. deep before a storm and 5.25 in. deep after it. How many inches of rain fell during the storm?

7. This railroad time-table shows, in the left-hand column, how many miles each station is from Denver. How far is it from Denver to Georgetown? from Arvada to Golden? from Golden to Forks Creek? from Forks Creek to Lawson? from Lawson to Georgetown?

MILES		P.M.
0.0	Denver	3.15
7.6	Arvada	3.41
15.9	Golden	4.02
28.7	Forks Creek	5.00
44.2	Lawson	6.06
49.9	Georgetown	6.26

8. Bring to class a time-table of a railroad near your home. Make up and solve five problems about it like those in ex. 7.

GRADED EXERCISES IN SUBTRACTING DECIMALS

Subtract the following and check the work:

1.	2.006 1.423	**8.**	8.232 4.987	**15.**	.9141 .6597	**22.**	1.7507 .0605
2.	8.587 6.802	**9.**	.8345 .3360	**16.**	.1556 .0796	**23.**	6.6370 5.3599
3.	9.130 8.894	**10.**	.5404 .3564	**17.**	2.717 .709	**24.**	9.9158 1.4789
4.	.8809 .1815	**11.**	5.005 4.000	**18.**	8.232 .446	**25.**	9.0625 .3287
5.	925.0 159.5	**12.**	2.714 .021	**19.**	150.3 3.4	**26.**	.00066 .00018
6.	9.939 8.9	**13.**	4.57 1.711	**20.**	.3292 .187	**27.**	11.166 3.
7.	6. 5.875	**14.**	5. .166	**21.**	7. 1.505	**28.**	.808 .23064

Copy the following. Then subtract and check:

29. $2 - .27$ **32.** $9 - 5.9876$ **35.** $.766 - .0065$

30. $6 - 1.42$ **33.** $9.3 - 7.951$ **36.** $.532 - .1463$

31. $9 - 1.3975$ **34.** $1.72 - .887$ **37.** $74 - 36.428$

38. $84 - 49.062$ **40.** $92.86 - 3.1875$

39. $87.812 - 38.7974$ **41.** $75.636 - 12.898$

IMPROVEMENT TEST No. 15

Test 15 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.
$8\frac{3}{4}$	$9\frac{7}{8}$	$7\frac{1}{2}$	$4\frac{1}{2}$	$7\frac{1}{5}$
$2\frac{1}{8}$	4	$8\frac{2}{3}$	6	4
5	$2\frac{1}{4}$	$5\frac{5}{6}$	$3\frac{2}{3}$	$2\frac{1}{2}$
$8\frac{9}{16}$	$3\frac{1}{2}$	$1\frac{1}{6}$	$9\frac{3}{4}$	$6\frac{7}{10}$

Test 15 B — Subtraction (Time 4 min.)

1.	2.	3.	4.
$7\frac{5}{8}$	$3\frac{7}{8}$	6	$7\frac{2}{5}$
$4\frac{1}{8}$	$1\frac{1}{2}$	$3\frac{3}{8}$	$2\frac{1}{2}$
5.	**6.**	**7.**	**8.**
$9\frac{1}{4}$	$8\frac{1}{2}$	7	$2\frac{2}{3}$
$1\frac{5}{8}$	$6\frac{1}{3}$	$6\frac{3}{16}$	$1\frac{1}{6}$
9.	**10.**	**11.**	**12.**
$1\frac{1}{2}$	$9\frac{1}{3}$	$8\frac{3}{4}$	$6\frac{4}{5}$
$\frac{3}{10}$	$5\frac{3}{4}$	$2\frac{3}{5}$	$4\frac{7}{10}$

Test 15 C — Multiplication (Time 3 min. after copying)

1. $\frac{3}{4}$ of 36	**2.** $\frac{5}{8} \times \frac{1}{10}$	**3.** $\frac{3}{5} \times 3\frac{1}{6}$
4. $\frac{2}{3}$ of 10	**5.** $1\frac{1}{2} \times \frac{14}{15}$	**6.** $2\frac{5}{8} \times 16$
7. $\frac{5}{6}$ of 14	**8.** $6\frac{3}{10} \times \frac{2}{3}$	**9.** $3\frac{1}{5} \times 3\frac{3}{4}$

Test 15 D — Division (Time 3 min. after copying)

1. $\frac{3}{4} \div 3$	**2.** $9 \div \frac{3}{16}$	**3.** $2\frac{1}{4} \div 12$
4. $\frac{8}{9} \div 4$	**5.** $\frac{3}{8} \div \frac{5}{12}$	**6.** $18 \div 2\frac{2}{3}$
7. $\frac{1}{4} \div \frac{1}{6}$	**8.** $1\frac{1}{2} \div \frac{9}{16}$	**9.** $4\frac{1}{5} \div 8\frac{2}{5}$

NOTE. For directions for taking Improvement Tests in fractions, see page 90 and the note on page 101.

MULTIPLYING DECIMALS

1. Edna is going to ride 9.4 mi. on a train. If the fare is \$.036 a mile, how much will her ticket cost?

To multiply .036 by 9.4, use this rule:

To multiply decimals, first multiply as with whole numbers. Then, beginning at the right, point off as many decimal places in the product as there are in the multiplier and the multiplicand together.

Since 9.4 has 1 decimal place and .036 has 3 places, point off 4 places in the product, which gives .3384.

\$.3384 may be written \$.34, which is correct to the nearest cent. Edna's ticket will cost \$.34.

To prove that .3384 is the right product, change .036 to $\frac{36}{1000}$ and 9.4 to $9\frac{4}{10}$, or $\frac{94}{10}$. Then multiply as shown below:

$$\frac{94}{10} \times \frac{36}{1000} = \frac{3384}{10000} = .3384$$

.036
9.4
144
324
.3384

Study the following problems:

A.		*B.*		*C.*		*D.*	
	1.95		.23		.015		.36
	46		.35		.05		500
	11 70		115		.00075		180.00
	78 0		69				
	89.70		.0805				

2. In *A*, how many decimal places are there in 1.95 and 46 together? how many in the answer?

3. In *B*, .23 has 2 places and .35 has 2 places; hence you must point off 4 decimal places in the answer. To do this, write a 0 before 805, making .0805.

4. In *C*, why do you write three 0's in the answer?

5. In *D*, you get 180.00 as answer. Why can you cross out the last two 0's in this answer?

ARE AMERICANS FOND OF SWEETS?

1. During 1913 the people of the United States used an average of 85.32 lb. of sugar per person. How many pounds of sugar did an average family of 7 use that year? If the sugar cost $.055 a pound, how much did the family of 7 pay for sugar for the year?

Find the result correct to the nearest cent.

2. During 1923 the people of this country used an average of 104.24 lb. of sugar per person. How many pounds did a family of 7 use? At an average of $.101 a pound, how much did the family spend for sugar in 1923?

3. In 1925 the average price of sugar dropped to $.072 a pound. Work ex. 2 again, using $.072 instead of $.101 as the price per pound.

4. How much more did the family of 7 spend for sugar in 1923 than in 1913? in 1925 than in 1913?

Some Other Uses of Decimals

1. Last year it cost Mr. Ball $.094 a mile to drive to and from his office each day, the round trip being 14.2 mi. How much, to the nearest cent, did each day's trip cost?

2. This year Mr. Ball has a larger car and it costs an average of $.112 a mile to run it. How much does each day's trip of 14.2 mi. cost now?

3. Last winter a town in Colorado had the following snowfalls: October, 9.9 in.; November, 14.0 in.; December, 79.3 in.; January, 23.9 in.; February, 20.2 in.; March, 63.2 in.; April, 16.8 in. How much snow fell last winter in that town?

GRADED EXERCISES IN MULTIPLYING DECIMALS

Multiply. Check the work by going over it again. Practice the hard groups until you make no mistakes.

Group							
A.	**1.** 1.38 × 76	**2.** 653 × .38	**3.** 8.72 × .8	**4.** 7.6 × .21
	5. 9.82 × 7.2	**6.** 5.61 × .7	**7.** .903 × 54	**8.** .29 × 1.6
B.	**9.** 54.6 × .09	**10.** 116 × .006	**11.** 350 × .002	**12.** 5.74 × .06
C.	**13.** .017 × 7	**14.** .079 × 3	**15.** .046 × 5	**16.** .038 × 9
D.	**17.** .64 × .12	**18.** .006 × .4	**19.** .048 × .3	**20.** .142 × .05
	21. .02 × .03	**22.** .052 × .14	**23.** .607 × .09	**24.** .141 × .13
	25. .006 × .007	**26.** .076 × .56	**27.** .0009 × .05	**28.** 3.29 × .018
E.	**29.** 300 × .03	**30.** .54 × 800	**31.** .58 × 600	**32.** 5.8 × 5000
F.	**33.** .900 × .29	**34.** .706 × .300	**35.** .9000 × .063	**36.** .305 × .700

Note. The examples are arranged in groups according to difficulty.

MAKING RAFTS

1. Since a pine board will float on water, you can see that it is lighter than water. Pine weighs .4 as much as water. If 1 cu. ft. of water weighs 62.5 lb., what is the weight of 1 cu. ft. of pine? of 5 cu. ft. of pine? of a pine beam 12 ft. $\times \frac{3}{4}$ ft. $\times$ 1 ft.?

2. If 1 cu. ft. of pine weighs 25 lb. and 1 cu. ft. of water weighs 62.5 lb., 1 cu. ft. of pine is 37.5 lb. lighter than 1 cu. ft. of water. Then 1 cu. ft. of pine, floating in the water, could carry 37.5 lb. without sinking. How many pounds could 10 cu. ft. of pine wood carry?

3. Dave and Jack made a raft of 6 pine beams, each 8 ft. $\times \frac{3}{4}$ ft. $\times \frac{1}{4}$ ft. How many cubic feet of pine did the raft contain? How many pounds could it support without sinking?

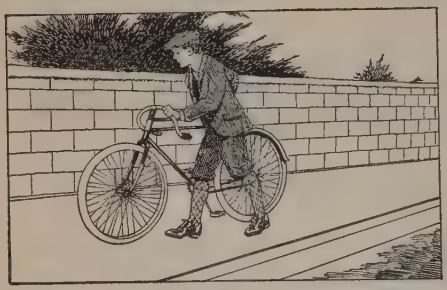
Dave weighs 90 lb. and Jack weighs 105 lb. Would the raft carry them?

Use any figures you need from ex. 2.

4. Sam made a raft of 8 pine boards, each 12 ft. $\times \frac{3}{4}$ ft. $\times \frac{1}{12}$ ft. How much weight would this raft carry?

5. Little Mary weighs 40 lb. Will a pine board 5 ft. $\times$ 2 ft. $\times \frac{1}{8}$ ft. support her weight on the water?

MEASURING DISTANCES WITH A BICYCLE



1. Will finds that the distance around his bicycle wheel, which is called its **circumference,** is 7.13 ft. This bicycle travels 7.13 ft. each time the wheel goes around once. To find the length of a new sidewalk, Will pushes his bicycle from one end of the walk to the other and finds that the wheel goes around 9 times. How long is the walk?

2. Will also measures the length of the school playground with his bicycle. The wheel goes around $28\frac{1}{2}$ times. Change $28\frac{1}{2}$ to 28.5 and find, to the nearest hundredth of a foot, how long the playground is. Use the circumference of the wheel as given in ex. 1.

3. Find, to the nearest hundredth of a foot, the width of the playground if the wheel goes around $16\frac{1}{4}$ times in crossing it. Change $16\frac{1}{4}$ to 16.25 before multiplying.

4. How far does Will's bicycle travel when the wheel goes around 83 times? $102\frac{1}{2}$ times? $99\frac{1}{4}$ times?

5. Edna's bicycle wheel has a circumference of 6.67 ft. How far, to the nearest hundredth of a foot, does it travel when the wheel goes around 93 times? $42\frac{1}{2}$ times? $62\frac{1}{4}$ times? $18\frac{1}{2}$ times?

6. Harold has a big hoop with a circumference of 20.4 ft. If the hoop goes around 47 times while Harold rolls it down a hill, how long is the hill?

PUT THE DECIMAL POINT IN THE RIGHT PLACE

Place the decimal point mentally in each product. Read the results like this: "eight-point-four."

1. 12 × .7 = 84	**2.** .7 × .9 = 63	**3.** .41 × .6 = 246	**4.** 6.7 × 5.8 = 3886
5. .42 × 2.3 = 966	**6.** .37 × .57 = 2109	**7.** .127 × 1.4 = 1778	**8.** .25 × .24 = 600
9. 49 × .06 = 294	**10.** 219 × .007 = 1533	**11.** 467 × .09 = 4203	**12.** 54.2 × .08 = 4336
13. .08 × 4 = 32	**14.** .09 × 7 = 63	**15.** .023 × 5 = 115	**16.** .066 × 8 = 528
17. .04 × 2 = 8	**18.** .06 × .09 = 54	**19.** 4.31 × .02 = 862	**20.** .049 × .03 = 147
21. .06 × .2 = 12	**22.** .25 × .26 = 650	**23.** .176 × .4 = 704	**24.** .027 × 3.7 = 999
25. 300 × .18 = 5400	**26.** 7000 × .006 = 42000	**27.** .456 × 50 = 22800	**28.** .49 × 400 = 19600
29. .270 × 89 = 24030	**30.** .026 × .40 = 1040	**31.** .705 × .80 = 56400	**32.** 5.63 × .900 = 506700

MULTIPLYING BY 10, 100, AND 1000

Our school is having a picnic at Echo Lake. Each fare is $1.25. How much will it cost if 10 children go? if 100 children go? if 1000 children go?

A	*B*	*C*
$1.25	$1.25	$1.25
10	100	1000
$12.50	$125.00	$1250.00

In *A*, you can get the answer $12.50 quickly by moving the decimal point in $1.25 one place to the right.

In *B*, you can get $125.00 quickly by moving the decimal point in $1.25 two places to the right.

In *C*, you can get $1250.00 by moving the decimal point in $1.25 three places to the right; but this time you must also insert a 0 before the decimal point because $1.25 has only two decimal places.

To multiply a number by 10, 100, *or* 1000, *move the decimal point as many places to the right as there are zeros in the multiplier.*

Exercises

Multiply mentally by 10 *and also by* 100:

1.	$6.43	$.58	$15.00	$19.	.8
2.	$2.85	$.27	$12.84	$275.	.09
3.	$1.54	$.42	$12.625	$158.	5.9

Multiply mentally by 1000 *and also by* 10:

4.	9.114	$6.125	$8.35	6.3	7
5.	8.206	$8.375	$4.26	2.4	30

6. How much do 10 baseballs cost at $.65 each?

7. How much do 10 yd. of silk cost at $1.25 a yard?

8. How much do 100 tickets cost at $.15 each?

DIVIDING BY 10, 100, AND 1000

1. Ruth saved \$14.60 in 10 wk. How much, on the average, did she save each week?

Since you multiply by 10 by moving the decimal point one place to the right, you divide by 10 by moving the decimal point one place to the left.

\$14.60 ÷ 10 = \$1.46

2. If 10 sheets of tinfoil are .14 in. thick, how thick is each sheet?

To divide by 10, place a zero before .14 and move the decimal point one place to the left.

.14 ÷ 10 = .014

3. Explain how each number below is divided by 100.

$135 \div 100 = 1.35$ $\$15.00 \div 100 = \$.15$ $1.3 \div 100 = .013$

In a whole number, like 135, the decimal point is understood to be at the right of the units' place.

To divide by 10, 100, *or* 1000, *move the decimal point as many places to the left as there are zeros in the divisor.*

Exercises

Divide the following mentally by 10:

1.	\$15.00	\$5.50	29.4	50	.8
2.	\$16.20	\$4.00	18.6	83	.26

Divide the following mentally by 100:

3.	\$198	\$23.00	61.2	\$5	6.8
4.	\$210	\$96.00	40.3	\$8	7.1

Divide mentally by 1000 *and also divide by* 10:

5.	\$5000	\$780	143.1	\$90	6

6. If 10 hats cost \$27.00, how much does 1 hat cost?

7. Jack sold 100 tickets for the school play for \$125.00. How much did he get for each ticket?

BUYING BY THE HUNDRED

Meat, cotton, and many other things are sold by the *hundredweight*, which equals 100 lb. and is written " cwt." Express and freight rates are also given per 100 pounds. Certain kinds of roofing are sold by the 100 square feet, while water and gas are often sold by the 100 cubic feet.

Exercises

1. If chicken feed costs \$3.60 per 100 lb., how much must George pay for 35 lb. of it? for 165 lb.?

If 100 lb. cost \$3.60, then 35 lb. cost $\frac{35}{100}$ of \$3.60.
Since $.35 \times \$3.60 = \$1.26$, George pays \$1.26 for 35 lb.
Similarly, for 165 lb., George pays $1.65 \times \$3.60$, or \$5.94.

2. If the express rate is \$2.28 per hundredweight, how much does it cost to ship a trunk weighing 225 lb.?

3. How much must John pay for the freight on a desk weighing 185 lb., if the rate is \$1.26 per hundredweight?

4. If meat scraps cost \$3.86 per hundredweight, how much does Henry pay for 45 lb. for his chickens?

5. How many hundredweight are there in 216 lb.? in 869 lb.? in 4260 lb.? in 1096 lb.? in 86 lb.?

6. In buying hardwood flooring, we add $\frac{1}{3}$ of the actual floor surface to allow for matching. How much does the maple flooring cost for a room $22\frac{1}{2}$ ft. long and 18 ft. wide at \$10.90 per 100 sq. ft.?

7. How much does a metal ceiling 24 ft. wide and 36 ft. long cost at \$6.98 per 100 sq. ft.?

8. At 32¢ per 100 cu. ft., what is the cost of the water needed to fill a swimming tank 60 ft. long and 20 ft. wide to a depth of $4\frac{1}{4}$ ft.?

IMPROVEMENT TEST No. 16

Test 16 A — Addition (Time 4 min.)

1.	2.	3.	4.	5.
6926	7983	5778	4859	8646
4645	6909	8663	4609	6716
9098	5782	6875	8597	3557
6833	7597	7248	5754	7455

6.	7.	8.	9.	10.
3145	1986	9171	6061	9375
3384	8097	7878	9478	4996
2934	2223	2919	6511	7474
8466	2346	2844	7985	6539

Test 16 B — Subtraction (Time 3 min.)

1.	2.	3.	4.	5.
6921	7032	6403	8711	9206
5474	2523	4520	2066	7913

6.	7.	8.	9.	10.
8679	4343	9644	8573	5502
3699	2569	8985	1768	2974

11.	12.	13.	14.	15.
5301	6297	8225	7688	8914
1333	1618	5468	4979	1218

Test 16 C — Addition (Time 4 min.)

1.	2.	3.	4.	5.
5938	7649	9523	1895	8658
6575	4639	1449	367	6261
696	380	3685	6668	7759
8234	2029	8750	851	6808
7743	873	1372	7119	443
888	9956	354	507	7891
6976	5769	885	9292	4471
4125	7643	9528	6748	529

NOTE. For additional tests in whole numbers, use the tests on pages 11, 21, 31, 55, 73, 119, and 141. The pupil should try to make a better record on these tests now than he did in the previous grade.

DIVIDING A DECIMAL BY A WHOLE NUMBER

1. Mr. Dodd drove a truck 209 mi. on 25 gal. of gasoline. How many miles did he average per gallon?

Dividing as in *A*, you get $8\frac{9}{25}$.

To avoid the remainder, write 209 as 209.00 and divide as in *B*. The decimal point in 8.36 comes directly above the decimal point in 209.00. 8.36 is equal to $8\frac{9}{25}$ because $.36 = \frac{36}{100} = \frac{9}{25}$.

Mr. Dodd averaged 8.36 mi. per gallon.

A. $8\frac{9}{25}$

$$25\overline{)209}$$
$$\underline{200}$$
$$9$$

B. 8.36

$$25\overline{)209.00}$$
$$\underline{200}$$
$$90$$
$$\underline{75}$$
$$150$$
$$\underline{150}$$

2. Mr. King drove a truck 198.4 mi. on 23 gal. of gasoline. How many miles per gallon was that?

You could write the quotient as $8.6\frac{6}{23}$; but it is better to annex two 0's after 198.4, making 198.400, as in *D*. This gives 8.626 as the answer, to three decimal places.

To write the answer correct to the nearest hundredth, change 8.626 to 8.63. To find it to the nearest tenth, you would carry the quotient only to two decimal places. This would give 8.62, which is 8.6 correct to the nearest tenth.

Mr. King averaged 8.63 mi. per gallon.

C. $8.6\frac{6}{23}$

$$23\overline{)198.4}$$
$$\underline{184}$$
$$144$$
$$\underline{138}$$
$$6$$

D. 8.626

$$23\overline{)198.400}$$
$$\underline{184}$$
$$144$$
$$\underline{138}$$
$$60$$
$$\underline{46}$$
$$140$$
$$\underline{138}$$
$$2$$

To divide a decimal by a whole number, place the decimal point in the quotient above the decimal point in the dividend. If there is a remainder, annex zeros to the dividend and continue to divide.

Carry the quotient to three decimal places for a result correct to the nearest hundredth, or to two decimal places for a result correct to the nearest tenth.

GRADED EXERCISES

Divide. If there is a remainder, annex 0*'s after the dividend and continue to divide until the quotient is exact.*

GROUP

A.	**1.** $51\overline{)166.26}$	**2.** $92\overline{)3256.8}$	**3.** $45\overline{)80.55}$
	4. $56\overline{)255.92}$	**5.** $33\overline{)1735.8}$	**6.** $79\overline{)291.51}$
	7. $67\overline{)240.53}$	**8.** $81\overline{)4187.7}$	**9.** $62\overline{)452.6}$
B.	**10.** $28\overline{)217}$	**11.** $52\overline{)429}$	**12.** $64\overline{)400}$
	13. $24\overline{)114}$	**14.** $25\overline{)93}$	**15.** $96\overline{)60}$
	16. $88\overline{)77}$	**17.** $64\overline{)56}$	**18.** $72\overline{)27}$
	19. $48\overline{)42}$	**20.** $40\overline{)25}$	**21.** $54\overline{)5157}$
	22. $22\overline{)1595}$	**23.** $74\overline{)6845}$	**24.** $42\overline{)3129}$
C.	**25.** $45\overline{)431.1}$	**26.** $36\overline{)343.8}$	**27.** $56\overline{)142.8}$

Divide. Carry the quotient to two decimal places; then write the result correct to the nearest tenth:

D.	**28.** $56\overline{)544}$	**29.** $32\overline{)265}$	**30.** $85\overline{)798}$
	31. $73\overline{)444}$	**32.** $91\overline{)835}$	**33.** $24\overline{)175}$
	34. $57\overline{)275}$	**35.** $73\overline{)305}$	**36.** $48\overline{)236}$
	37. $92\overline{)769}$	**38.** $55\overline{)546.1}$	**39.** $61\overline{)239.1}$
	40. $73\overline{)359.2}$	**41.** $92\overline{)269.6}$	**42.** $29\overline{)265.1}$
	43. $37\overline{)127.4}$	**44.** $56\overline{)358.9}$	**45.** $78\overline{)465.6}$

Divide. Carry the quotient to three decimal places; then write the result correct to the nearest hundredth:

E.	**46.** $22\overline{)119}$	**47.** $74\overline{)141}$	**48.** $84\overline{)196}$
	49. $69\overline{)248}$	**50.** $85\overline{)668}$	**51.** $43\overline{)208}$
	52. $36\overline{)255}$	**53.** $23\overline{)124}$	**54.** $66\overline{)158.9}$
	55. $71\overline{)262.6}$	**56.** $53\overline{)222.1}$	**57.** $79\overline{)377.8}$

PROBLEMS IN DIVISION OF DECIMALS

1. Charlotte gained 34.5 lb. in 3 yr. What was the average number of pounds she gained per year?

2. On Mr. Owen's farm a cow gave 132.3 lb. of milk in 1 wk. How many pounds per day was that?

3. Fred wants to buy a scout uniform costing $9.45. If he works 35 days, how much money will he have to save each day in order to save $9.45?

4. During August Mr. Sage used 68 gal. of gasoline, which cost him $15.64 in all. Find the average price per gallon of the gasoline.

5. Mr. Jackson earns $55 a week, working 44 hr. How much does he earn per hour?

6. Mr. Brant earns $60 a week, working 44 hr. Find, to the nearest cent, how much he earns per hour.

7. It takes a train 45 min. to go from Barton to Scoville. The distance is 31 mi. Find, to the nearest tenth of a mile, how far the train goes per minute.

8. A truck used 14 gal. of gasoline for a trip of 85.6 mi. Find, to the nearest tenth of a mile, how many miles it traveled on 1 gal. of gasoline.

9. On another trip the same truck went 148 mi. on 23 gal. of gasoline. Did it make as many miles per gallon as it did in ex. 8?

10. For $150 the Manor School hires a steamboat to take 602 pupils on an excursion. Find, to the nearest cent, each child's share of the expense.

11. If Irene's father goes 22 mi. an hour in his automobile, how long will a trip of 118.8 mi. take him?

CHANGING FRACTIONS TO DECIMALS

Guy runs an adding machine in a store. On it he can add whole numbers and decimals; but there are no keys for adding fractions. To add $15\frac{3}{8}$ and $53\frac{1}{2}$, he changes the fractions to decimals and adds on the machine as in *A*. The sum is 68.875. To see if Guy is right, Ted adds the fractions in pencil as in *B*, getting $68\frac{7}{8}$. Does $68.875 = 68\frac{7}{8}$?

A.
$$\begin{array}{r} 15.375 \\ 53.5 \\ \hline 68.875 \end{array}$$

B.
$$\begin{array}{r} 15\frac{3}{8} = 15\frac{3}{8} \\ 53\frac{1}{2} = 53\frac{4}{8} \\ \hline 68\frac{7}{8} \end{array}$$

To change $\frac{3}{8}$ to a decimal Guy writes 3 as 3.000 and divides by 8, as shown at the right.

$$\begin{array}{r} 8\overline{)3.000} \\ .375 \end{array}$$

To change a common fraction to a decimal, write a decimal point after the numerator, annex zeros, and divide by the denominator.

Exercises

Change to exact decimals:

1. $\frac{1}{4}$ $\frac{1}{5}$ $\frac{7}{20}$ $\frac{2}{5}$ $\frac{17}{50}$ $\frac{3}{20}$ $\frac{8}{25}$

2. $\frac{5}{8}$ $\frac{3}{4}$ $\frac{23}{25}$ $\frac{3}{5}$ $\frac{3}{25}$ $\frac{19}{20}$ $\frac{49}{50}$

3. $\frac{9}{25}$ $\frac{1}{8}$ $\frac{43}{125}$ $\frac{7}{8}$ $\frac{113}{250}$ $\frac{3}{16}$ $\frac{5}{16}$

Add by changing the fractions to decimals as Guy did. Then add the fractions as Ted did. Are the answers equal?

4. $2\frac{1}{4}$ / $5\frac{1}{2}$ **5.** $6\frac{1}{8}$ / $2\frac{3}{4}$ **6.** $3\frac{1}{5}$ / $2\frac{7}{10}$ **7.** $16\frac{7}{8}$ / $22\frac{3}{4}$ **8.** $12\frac{5}{8}$ / $3\frac{3}{4}$

CHANGING FRACTIONS TO INCOMPLETE DECIMALS

1. Change $\frac{5}{6}$ to a decimal.

In changing $\frac{5}{6}$ to a decimal, you find that the quotient never comes out exact, no matter how many 0's you annex. In such a case the resulting decimal is called an **incomplete decimal.** It is usually sufficient to carry the division to three or four decimal places. Thus, in the case of $\frac{5}{6}$, call the answer .833 or .8333. To show that the exact value is a little more than .83 you may write it as .83+.

$$\begin{array}{r} 6\overline{)5.0000} \\ .8333\frac{1}{3} \end{array}$$

2. Change $\frac{19}{43}$ to a decimal, to the nearest thousandth.

Carry the division to four decimal places, which gives .4418. Since the fourth figure is more than 5, make the third figure 1 larger. Thus, .4418 is .442 to the *nearest thousandth.* When the fourth figure is less than 5, drop it. Thus, .4413 would be .441 to the nearest thousandth.

If you had need for an answer correct only to the *nearest hundredth,* then you would carry the division to three decimal places, which would give .441. Writing .441 correct to the nearest hundredth, you get .44.

$$\begin{array}{r} .4418 \\ 43\overline{)19.0000} \\ 172 \\ \hline 180 \\ 172 \\ \hline 80 \\ 43 \\ \hline 370 \\ 344 \\ \hline 26 \end{array}$$

Exercises

Change to decimals, correct to the nearest hundredth:

1.	$\frac{2}{3}$	$\frac{1}{6}$	$\frac{4}{9}$	$\frac{19}{21}$	$\frac{5}{11}$	$\frac{7}{9}$	$\frac{2}{13}$
2.	$\frac{4}{7}$	$\frac{7}{11}$	$\frac{1}{7}$	$\frac{9}{11}$	$\frac{2}{19}$	$\frac{6}{7}$	$\frac{2}{17}$
3.	$\frac{5}{12}$	$\frac{7}{12}$	$\frac{3}{7}$	$\frac{5}{63}$	$\frac{13}{15}$	$\frac{5}{9}$	$\frac{1}{19}$

Change to decimals, correct to the nearest thousandth:

4.	$\frac{5}{7}$	$\frac{8}{15}$	$\frac{29}{45}$	$\frac{5}{36}$	$\frac{25}{64}$	$\frac{17}{18}$	$\frac{283}{665}$
5.	$\frac{53}{71}$	$\frac{28}{34}$	$\frac{22}{43}$	$\frac{177}{431}$	$\frac{61}{81}$	$\frac{22}{59}$	$\frac{18}{111}$
6.	$\frac{39}{76}$	$\frac{69}{75}$	$\frac{27}{52}$	$\frac{181}{544}$	$\frac{5}{32}$	$\frac{17}{37}$	$\frac{12}{999}$

WHEN DECIMALS ARE MORE CONVENIENT THAN FRACTIONS

Mt. Mansfield in Vermont is 4364 ft. high. What part of a mile high is it?

Since 1 mi. = 5280 ft., Mt. Mansfield is $\frac{4364}{5280}$ of a mile high. Reducing $\frac{4364}{5280}$ to lowest terms, you get $\frac{1091}{1320}$, which is still an awkward fraction. It is much simpler to change $\frac{4364}{5280}$ directly to a decimal. Doing this, you get $4364 \div 5280 = .826$. Hence Mt. Mansfield is .83 mi. high, to the nearest hundredth of a mile.

Exercises

Express each decimal to the nearest hundredth.

1. The steamship *Leviathan* is 907 ft. long. What decimal part of a mile long is it?

2. The Woolworth Building in New York is 792 ft. high. What decimal part of a mile high is it?

3. Ed went from Boston to India via the Panama Canal in 61 da. What decimal part of a year (365 da.) did the trip take?

4. James walks $5\frac{1}{2}$ blocks to get to school. What decimal part of a mile is that if 1 block = 264 ft.?

5. Mt. Vesuvius in Italy has an altitude of 4300 ft. What decimal part of a mile high is it?

6. In a weight-lifting contest a man lifts 217 lb. What decimal part of a ton does he lift?

7. Ella picks 27 lb. of cherries. What part of a bushel is that if 1 bu. of cherries = 50 lb.?

8. It is 3180 mi. from New York to San Francisco and 909 mi. from New York to Chicago. In traveling from New York to San Francisco, what part of the trip have you finished when you reach Chicago?

A FRACTION AT THE END OF A DECIMAL

1. You know that you can reduce $\frac{1}{8}$ to a decimal by dividing the numerator by the denominator.

In *A* the division is carried to hundredths and the remainder is expressed as a fraction, giving $.12\frac{1}{2}$.

In *B* the division is carried to thousandths, giving .125. $.12\frac{1}{2} = .125$.

A	*B*
8)1.00	8)1.000
$.12\frac{1}{2}$	.125

When $\frac{1}{2}$ occurs at the end of a decimal, you may always write 5 in place of it, as shown below.

$.37\frac{1}{2} = .375$ $.62\frac{1}{2} = .625$ $.4\frac{1}{2} = .45$ $.112\frac{1}{2} = .1125$

2. If you reduce $\frac{5}{16}$ to a decimal, you get $.31\frac{1}{4}$ by carrying the result to two places and .3125 by carrying it to four places. Then $.31\frac{1}{4} = .3125$. When $\frac{1}{4}$ occurs at the end of a decimal, you may write 25 in place of it; $\frac{3}{4}$ at the end of a decimal may be replaced by 75.

$.9\frac{1}{4} = .925$ $.06\frac{1}{4} = .0625$ $.17\frac{3}{4} = .1775$ $.05\frac{3}{4} = .0575$

3. In like manner, $\frac{1}{3}$ at the end of a decimal becomes $33\frac{1}{3}$ or 33, while $\frac{2}{3}$ may be replaced by $66\frac{2}{3}$ or 67.

$.8\frac{1}{3} = .833\frac{1}{3}$ or .833 $.16\frac{2}{3} = .1666\frac{2}{3}$ or .1667

Exercises

Write the following entirely as decimals:

1. $.07\frac{1}{2}$	**6.** $9.06\frac{3}{4}$	**11.** $4.00\frac{1}{4}$	**16.** $.116\frac{1}{4}$
2. $.09\frac{1}{4}$	**7.** $1.83\frac{1}{3}$	**12.** $19.4\frac{1}{4}$	**17.** $.105\frac{1}{2}$
3. $.28\frac{3}{4}$	**8.** $2.50\frac{1}{4}$	**13.** $2.58\frac{1}{3}$	**18.** $1.00\frac{1}{2}$
4. $2.2\frac{1}{2}$	**9.** $7.36\frac{1}{2}$	**14.** $1.26\frac{1}{3}$	**19.** $4.66\frac{2}{3}$
5. $3.7\frac{3}{4}$	**10.** $9.21\frac{2}{3}$	**15.** $9.01\frac{3}{4}$	**20.** $.106\frac{2}{3}$

21. Find the cost of driving 65 mi. at $\$.08\frac{3}{4}$ a mile.

PREPARING TO DIVIDE BY A DECIMAL

1. Study carefully these problems in division:

A. $3\overline{)15}$ $\quad$ *B.* $30\overline{)150}$ $\quad$ *C.* $300\overline{)1500}$

5 $\quad$ 5 $\quad$ 5

In *B* both the dividend and the divisor are 10 times as great as in *A*; but both *A* and *B* have 5 as quotient.

In *C* both the dividend and the divisor are 100 times as great as in *A*, but the quotient is still 5.

Multiplying both the dividend and the divisor by 10, *by* 100, *or by* 1000 *does not change the quotient.*

2. If the divisor is a decimal, you can change it to a whole number by the above rule. For example, if you multiply both numbers in *D* by 10, you get *E*.

D $\quad$ *E*

$3.1\overline{)15.5}$ $\quad$ $31\overline{)155}$

DIVIDING BY A DECIMAL

1. John wants to buy a bicycle for \$29.25. If he saves \$2.25 a week, in how many weeks will he have \$29.25?

In dividing 29.25 by 2.25, first change the divisor to a whole number. To do this, multiply both 2.25 and 29.25 by 100 by moving each decimal point 2 places to the right. Then divide 2925 by 225.

John can save \$29.25 in 13 wk.

$$2.25\overline{)29.25} \qquad 225\overline{)2925}$$

$$\begin{array}{r} 13 \\ 225\overline{)2925} \\ 225 \\ \hline 675 \\ 675 \\ \hline \end{array}$$

Divide, first changing each divisor to a whole number:

2. \$13.75 ÷ \$1.25

3. \$31.95 ÷ \$0.71

4. \$27.95 ÷ \$2.15

5. \$26.25 ÷ \$1.75

6. \$70.55 ÷ \$0.85

7. \$20.25 ÷ \$1.35

8. \$25.50 ÷ \$0.75

9. \$85.33 ÷ \$0.53

DICK SAVES TIME IN DIVIDING DECIMALS

How long will it take an airplane to fly $138\frac{3}{4}$ mi. if it goes $1\frac{1}{2}$ mi. a minute?

Dick changes $1\frac{1}{2}$ to 1.5 and $138\frac{3}{4}$ to 138.75. He must divide 138.75 by 1.5. To make the divisor, 1.5, a whole number, he multiplies both 1.5 and 138.75 by 10 by moving each decimal point 1 place to the right. He uses a caret (∧) to indicate the new position of each decimal point. He places the decimal point in the quotient directly above the caret in 138.7∧5.

```
          92.5          Check
1.5∧)138.7∧5            92.5
     135                 1.5
      37                4625
      30                925
       75              138.75
       75
```

The airplane flies $138\frac{3}{4}$ mi. in 92.5 min., or $92\frac{1}{2}$ min.

By using the carets Dick is saved the trouble of erasing the decimal points or of writing the problem over again as you had to do at the bottom of page 245. Dick can also easily tell what the original dividend and divisor are when he wishes to check his work.

Dick checks by multiplying 92.5 by the original divisor, 1.5. If the product equals the original dividend, 138.75, the work is right.

In dividing by a decimal, place a caret (∧) as many places to the right of the decimal point in both divisor and dividend as there are decimal places in the divisor. Place the decimal point in the quotient directly above the caret in the dividend.

If the work is right, the quotient and the divisor together have as many decimal places as the dividend has.

Exercises

Divide the following and check the work:

1. 112.32 ÷ 1.3
2. 105.14 ÷ 1.4
3. 163.28 ÷ 2.6
4. 194.15 ÷ 5.5
5. \$24.05 ÷ \$.13
6. \$84.06 ÷ \$.18
7. \$200.34 ÷ \$.53
8. \$303.55 ÷ \$.65

PROBLEMS IN DIVIDING BY DECIMALS

In these problems first change all fractions to decimals.

1. The first day that Ellen had her new bicycle she rode $13\frac{3}{4}$ mi. in $2\frac{1}{2}$ hr. How fast did she go per hour?

2. May Smith earns \$13.75 a week. As she works only half a day on Saturday, she works $5\frac{1}{2}$ da. a week in all. How much does she earn per day?

3. During a rainstorm that lasted 9.5 hr., 1.71 in. of rain fell. Find, to the nearest hundredth of an inch, the average rainfall per hour.

4. Charles and his sister want to buy a radio for \$21.25. Charles can save \$.75 a week and his sister can save \$.50. How long will it take them to save \$21.25?

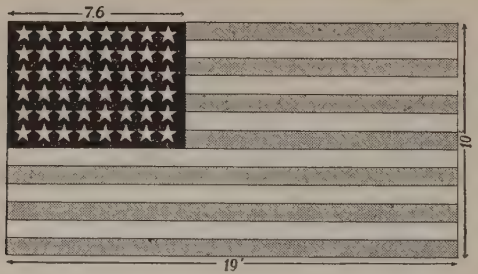
5. A bus driver can go 6.4 mi. on 1 gal. of gasoline. How many gallons will he use in driving 102.4 mi.?

6. Jim rides a mile in $7\frac{1}{2}$ min. on his bicycle. He finds that it takes him $26\frac{1}{4}$ min. to ride to the village. How many miles is it to the village?

Divide the following and check the work:

7. $5.1\overline{)173.91}$	**15.** $6.2\overline{)271.56}$	**23.** $6.43\overline{)280.348}$
8. $8.8\overline{)28.776}$	**16.** $.96\overline{)39.264}$	**24.** $2.16\overline{)122.904}$
9. $.55\overline{)44.495}$	**17.** $7.8\overline{)652.86}$	**25.** $3.12\overline{)285.168}$
10. $.73\overline{)51.246}$	**18.** $4.5\overline{)336.15}$	**26.** $21.4\overline{)1074.28}$
11. $.79\overline{)4.2739}$	**19.** $3.7\overline{)17.242}$	**27.** $2.97\overline{)244.431}$
12. $6.1\overline{)347.09}$	**20.** $8.2\overline{)597.78}$	**28.** $.481\overline{)29.6777}$
13. $.31\overline{)1.7577}$	**21.** $7.2\overline{)349.92}$	**29.** $73.4\overline{)663.536}$
14. $.025\overline{)1.3175}$	**22.** $.87\overline{)49.851}$	**30.** $4.28\overline{)13.7388}$

HOW TO MAKE AN AMERICAN FLAG



The proportions of the United States flag as fixed by official regulations are as follows:

Its length is 1.9 times its width. Each stripe is $\frac{1}{13}$ of the width. The length of the blue field is .76 of the width of the flag, and the width of the blue field equals 7 stripes, or $\frac{7}{13}$ of the flag's width.

The flag shown above has a width of 10 ft. Its other dimensions are found as follows:

The length of the flag $= 1.9 \times 10$ ft., or 19 ft.
The length of the blue field $= .76 \times 10$ ft., or 7.6 ft.
The width of the blue field $= \frac{7}{13}$ of 10 ft., or 5.4 ft.

Exercises

1. Pauline is making a United States flag 4.75 ft. wide: How long should she make the flag?

2. How wide, to the nearest tenth of an inch, should Pauline make each stripe? How long and how wide should the blue field be?

3. Irene's class is making a flag 12 ft. long. How wide, to the nearest tenth of a foot, should the flag be? Give the dimensions of its blue field.

4. How wide are the stripes in the regular flag, 10 ft.$\times$19 ft., shown in the picture on page 248?

5. The flag at Albert's school is 8 ft.$\times$14 ft. Is it an official United States flag? How long should a flag 8 ft. wide be to have the right shape?

Arthur sees these flags advertised in a catalogue. Which of them are of the official proportions?

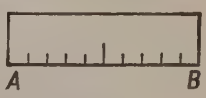
6. $4\frac{1}{2}$ ft.$\times$8 ft. 6 ft.$\times$11.4 ft. 10 ft.$\times$19 ft.

7. 5 ft.$\times$9.5 ft. 8 ft.$\times$12 ft. 12 ft.$\times$21 ft.

8. Caroline found that each stripe of a very large regulation flag used in a street parade was 18 in. wide. She could not get the other measures. How long and how wide was the flag?

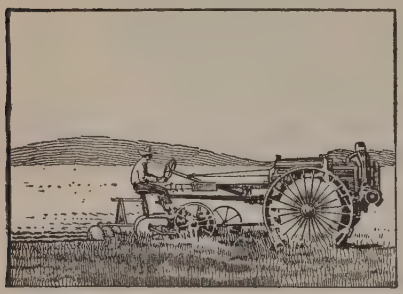
9. A gardener wishes to lay out a flower bed in the shape of a regulation United States flag. If the bed is 60 ft. wide, find, to the nearest tenth of a foot: (*a*) the length of the bed; (*b*) the dimensions of the blue field; (*c*) the width of each stripe.

10. Line AB is 1 in. long. It is divided into tenths. Hence each small space equals $\frac{1}{10}$ in., or .1 in. Make a ruler of cardboard 12 in. long and divide each inch into tenths. Place the edge of the cardboard along line AB to get the right length for each small space.



11. On the blackboard draw an American flag 22 in. wide. What will be the length of the flag, to the nearest tenth of an inch? What will be the width of each stripe? the length and the width of the blue field? Use the ruler you made in ex. 10 to measure the tenths of an inch.

IS IT CHEAPER TO BUY A TRACTOR?



1. Dan's father bought a 3-plow tractor for his 340-acre farm. This tractor can plow 8.6 A. a day. How many days will it take it to plow 111.8 A.?

2. Dan used to plow an average of 2.6 A. a day with a 3-horse team. How long did it take him to plow 111.8 A.?

3. How many days' time was saved by plowing the 111.8 A. with the tractor instead of with horses?

4. The tractor used an average of 2.9 gal. of gasoline per acre. How many gallons, to the nearest whole gallon, were needed for the 111.8 A.?

5. After getting the tractor, Dan's father sold 3 horses that were costing \$196 each yearly, and did without a hired man who worked 72 da. for \$2.75 a day. Find the total yearly savings on these items.

6. Dan read that the average costs per acre for plowing with the tractor were: cost of tractor, 62¢; repairs, 16.5¢; gasoline, 98¢; oil, 15.5¢; wages of operator, 47.5¢. Find the total cost per acre.

7. A day's plowing with horses cost \$5.20 for the horses and plow and \$3.25 for wages. Find the total cost per acre if 2.6 A. were plowed in a day.

8. How much cheaper per acre is the plowing with a tractor than with horses? Have you found also that a tractor is quicker than horses?

HARDER WORK IN DECIMALS

1. Charles pays \$2.34 for a railroad ticket to Long Lake. At \$.036 a mile, for how many miles is the ticket?

Since there are 3 decimal places in the divisor, .036, and only 2 places in the dividend, 2.34, write a 0 after 2.34 so that you can put the caret 3 places to the right of the decimal point, thus: $2.340_{\wedge}$. Place the decimal point in the quotient above the caret.

The quotient is 65.

Hence the ticket is for 65 mi.

Check by multiplying .036 by 5.

$$\begin{array}{r} 65. \\ .036_{\wedge})\overline{2.340_{\wedge}} \\ 2\ 16 \\ \hline 180 \\ 180 \\ \hline \end{array}$$

2. Divide .15254 by 5.8.

Place the decimal point in the quotient directly above the caret. Place 2 in the quotient directly above the 2 of 152. Write 0 before 2 in the quotient to fill the space at the right of the decimal point. The quotient, .0263, has 4 decimal places. This is correct because .0263 and 5.8 together have 5 decimal places and the dividend also has 5 places.

To check, multiply .0263 by 5.8.

$$\begin{array}{r} .0263 \\ 5.8_{\wedge})\overline{.1_{\wedge}5254} \\ 1\ 16 \\ \hline 365 \\ 348 \\ \hline 174 \\ 174 \\ \hline \end{array}$$

The quotient and the divisor together should have as many decimal places as the dividend has.

Some Airplane Records

Find answers to the nearest tenth of a mile.

1. A monoplane flew 2520.5 mi. from Mineola, N. Y., to San Diego, Calif., in 26.75 hr. Find its speed per hour.

2. In 1919 Alcock and Brown flew 1962 mi. across the Atlantic Ocean in 16.2 hr. Find the average speed per hour.

3. In 1925 Fernand Lasne broke a world record by flying 621 mi. in 4.02 hr. Find his speed per hour.

GRADED EXERCISES IN DIVIDING BY DECIMALS

Divide and check. In short division, place the decimal point in the quotient below the caret:

1. .3)$\overline{.36}$ **5.** .5)$\overline{.0285}$ **9.** .9)$\overline{.0333}$

2. .8)$\overline{8.8}$ **6.** .8)$\overline{.0664}$ **10.** .08)$\overline{55.2}$

3. .9)$\overline{.54}$ **7.** .02)$\overline{1.814}$ **11.** .04)$\overline{26.8}$

4. .03)$\overline{.177}$ **8.** .004)$\overline{.336}$ **12.** .005)$\overline{2.45}$

Divide the following and check the work:

13. 4.1)$\overline{147.19}$ **20.** .028)$\overline{10.304}$ **27.** 3.9)$\overline{.20007}$

14. .94)$\overline{11.656}$ **21.** .092)$\overline{23.736}$ **28.** .83)$\overline{65238}$

15. .63)$\overline{224.91}$ **22.** 7.2)$\overline{.42552}$ **29.** .51)$\overline{16269}$

16. 7.7)$\overline{329.56}$ **23.** 6.4)$\overline{.51968}$ **30.** .29)$\overline{1270.2}$

17. 5.3)$\overline{43.778}$ **24.** 7.6)$\overline{.19304}$ **31.** .26)$\overline{1747.2}$

18. 6.5)$\overline{2996.5}$ **25.** 2.9)$\overline{.24389}$ **32.** .022)$\overline{135.08}$

19. .022)$\overline{11.616}$ **26.** 7.7)$\overline{.41811}$ **33.** .074)$\overline{286.38}$

Divide. Carry the quotient to the nearest hundredth:

34. 8.6)$\overline{753.96}$ **38.** 9.2)$\overline{45.341}$ **42.** 7.7)$\overline{399}$

35. 4.6)$\overline{24.476}$ **39.** 5.8)$\overline{38.161}$ **43.** .52)$\overline{438}$

36. .57)$\overline{1.3393}$ **40.** .96)$\overline{7.3058}$ **44.** 4.6)$\overline{1493}$

37. .53)$\overline{3.1119}$ **41.** .39)$\overline{34.7254}$ **45.** 7.2)$\overline{49.171}$

PUT THE DECIMAL POINT IN THE RIGHT PLACE

In the following the correct figures of the quotients are given, but the decimal points are omitted. Put the decimal point in the right position in each quotient and insert any missing 0's. Give the results orally, thus: " one-point-two."

1. .6)$\overline{.72}$ — 12

2. .8)$\overline{.24}$ — 3

3. .5)$\overline{1.65}$ — 33

4. 2.7)$\overline{7.02}$ — 26

5. .39)$\overline{.0819}$ — 21

6. 8.7)$\overline{.2001}$ — 23

7. .73)$\overline{6394.8}$ — 87 6

8. 11.1)$\overline{410.7}$ — 3 7

9. .035)$\overline{3.255}$ — 93

10. .496)$\overline{49.6}$ — 1

11. .019)$\overline{1.026}$ — 54

12. .124)$\overline{793.6}$ — 6 4

13. .079)$\overline{1.817}$ — 23

14. 38.4)$\overline{1.5744}$ — 41

15. .053)$\overline{28.461}$ — 537

16. 26.4)$\overline{.16632}$ — 63

17. 4.88)$\overline{.28304}$ — 58

18. .051)$\overline{647.7}$ — 12 7

19. 62.5)$\overline{153.125}$ — 245

20. 6.25)$\overline{1531.25}$ — 2 45

21. 62.5)$\overline{15.3125}$ — 245

22. 6.25)$\overline{.153125}$ — 245

23. 6.25)$\overline{15312.5}$ — 24 5

24. 62.5)$\overline{.153125}$ — 245

25. .625)$\overline{15312.5}$ — 24 5

26. .0625)$\overline{15.3125}$ — 245

27. .0625)$\overline{153.125}$ — 245

CAN YOU FIND WALTER'S MISTAKES?

Check each of Walter's problems by multiplying the quotient by the divisor. If the work is wrong, find the mistakes and do the problems correctly. Tell how Walter can avoid these mistakes another time.

1. $7\overline{).7}$
1

2. $.9_\wedge\overline{)9.0_\wedge}$
$1\ 0$

3. $.4_\wedge\overline{).8_\wedge 0}$
$2\ 0$

4. $3.2_\wedge\overline{)11.8_\wedge 4}$
$3\ 7.$
$9\ 6$
$2\ 24$
$2\ 24$

5. $7.5_\wedge\overline{).1_\wedge 8975}$
$.253$
$1\ 50$
397
375
225
225

6. $5.4_\wedge\overline{).3_\wedge 9744}$
$.736$
$3\ 78$
194
162
324
324

7. $.69\overline{)195.27}$
2.83
138
572
552
207
207

8. $.44\overline{)19.9_\wedge 32}$
4.53
$17\ 6$
$2\ 33$
$2\ 20$
$1\ 32$
$1\ 32$

9. $.87\overline{)8099.7_\wedge}$
$93\ 1.$
783
269
261
87
87

10. $.84_\wedge\overline{)6392.40_\wedge}$
$76\ 10.$
588
512
504
84
84

11. $.037_\wedge\overline{)19.35_\wedge 1}$
52.3
$18\ 5$
85
74
111
111

12. $5.3\overline{)128_\wedge 7.9}$
$2.4\ 3$
106
227
212
159
159

IMPROVEMENT TEST No. 17

Test 17 A — Addition (Time 4 min.)

1. $6\frac{5}{8} + 4$
2. $8\frac{2}{3} + 5\frac{1}{3}$
3. $6\frac{3}{4} + 7\frac{3}{8}$
4. $9\frac{1}{2} + 2\frac{3}{5}$
5. $8\frac{7}{8} + 6\frac{7}{8}$
6. $1\frac{1}{2} + 8\frac{9}{10}$
7. $6\frac{2}{3} + 9\frac{1}{8}$
8. $7\frac{2}{3} + \frac{1}{2}$
9. $2\frac{2}{5} + 3\frac{1}{3}$
10. $2\frac{5}{8} + 5\frac{7}{16}$
11. $7\frac{1}{6} + 3\frac{1}{4}$
12. $8\frac{1}{3} + 1\frac{3}{4}$

Test 17 B — Multiplication (Time 4 min. after copying)

1. $\$1.24 \times 3\frac{1}{2}$
2. $\$2.16 \times 1\frac{3}{4}$
3. $17\frac{1}{4} \times 9$
4. $\frac{1}{4} \times \frac{1}{2}$
5. $\frac{2}{3} \times 15$
6. $6\frac{3}{4} \times \frac{8}{9}$
7. $\frac{2}{3} \times \frac{5}{8}$
8. $1\frac{1}{4} \times 12$
9. $4\frac{2}{3} \times 4\frac{1}{2}$
10. $\frac{9}{10} \times \frac{5}{6}$
11. $10 \times 2\frac{1}{4}$
12. $1\frac{1}{5} \times 1\frac{7}{8}$

Test 17 C — Division (Time 4 min. after copying)

1. $\frac{5}{6} \div \frac{1}{12}$
2. $2\frac{1}{3} \div 2$
3. $\frac{1}{16} \div \frac{1}{16}$
4. $\frac{3}{4} \div \frac{3}{16}$
5. $6\frac{1}{4} \div 5$
6. $\frac{1}{8} \div 1\frac{1}{4}$
7. $3 \div \frac{9}{10}$
8. $27 \div 4\frac{1}{2}$
9. $5\frac{1}{3} \div 2\frac{2}{3}$
10. $\frac{9}{16} \div \frac{15}{16}$
11. $7\frac{1}{2} \div 10$
12. $3\frac{3}{5} \div 1\frac{1}{8}$

SOME AMUSEMENTS WITH DECIMALS

1. In changing $\frac{2}{11}$ to a decimal, Mary tried to make the division come out exact by annexing 0's. To her surprise, the number 18 was repeated over and over again in the answer. Do you suppose 18 would continue to repeat in the quotient if she annexed 6 more zeros? Try it.

```
.181818
11)2.000000
   11
   90
   88
   20
   11
   90
   88
   20
   11
   90
   88
```

2. Paul found these interesting repeating decimals. Work each one to see if you can get these same answers.

$\frac{1}{9} = .11111111\cdots$ $\quad\quad$ $\frac{4}{33} = .121212\cdots$

$\frac{5}{37} = .135135135\cdots$ $\quad\quad$ $\frac{1}{27} = .037037\cdots$

These fractions also change to interesting decimals. Continue the division in each to 6 decimal places:

3. $\frac{2}{9}$	**8.** $\frac{4}{11}$	**13.** $\frac{14}{99}$	**18.** $\frac{30}{37}$	**23.** $\frac{18}{111}$
4. $\frac{4}{9}$	**9.** $\frac{1}{99}$	**14.** $\frac{17}{18}$	**19.** $\frac{5}{36}$	**24.** $\frac{41}{111}$
5. $\frac{7}{9}$	**10.** $\frac{7}{11}$	**15.** $\frac{13}{15}$	**20.** $\frac{13}{27}$	**25.** $\frac{246}{999}$
6. $\frac{8}{9}$	**11.** $\frac{8}{15}$	**16.** $\frac{3}{11}$	**21.** $\frac{7}{37}$	**26.** $\frac{63}{111}$
7. $\frac{6}{11}$	**12.** $\frac{29}{45}$	**17.** $\frac{5}{11}$	**22.** $\frac{1}{111}$	**27.** $\frac{123}{999}$

28. Write each answer in ex. 3 to 22 as a decimal, correct to hundredths; correct to thousandths.

29. You must carry the fraction $\frac{13717421}{111111111}$ to 16 decimal places to get the magic answer. Try to do it. Then tell, without dividing, what the answer is to 24 decimal places; also to 32 decimal places.

NOTE. In practical life you rarely have to carry results to as many decimal places as you did above. In business you usually carry decimals to the *nearest hundredth* or to the *nearest thousandth*.

THE COST OF WASTING WATER

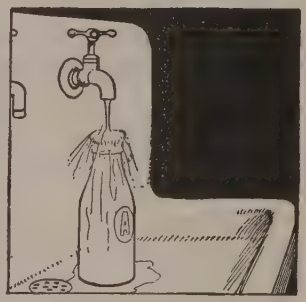
A $\frac{1}{2}$-inch faucet in Mrs. Hall's kitchen discharges 1140 gal. of water an hour if it is *wide open*, 1080 gal. an hour if *half open*, and 60 gal. an hour if *almost closed*.

1. If 7.5 gal. = 1 cu. ft., how many cubic feet of water does the faucet discharge per hour when it is wide open? when half open? when almost closed?

2. At 35¢ per 100 cu. ft., find the cost of the water discharged in an hour when the faucet is wide open.

152 cu. ft. of water are discharged in 1 hr. (ex. 1). Since 152 cu. ft. equal 1.52×100 cu. ft., then 152 cu. ft. cost 1.52 times as much as 100 cu. ft.

3. To keep the milk cool Mrs. Hall let the water with the faucet almost closed run over a bottle of milk for 8 hr. every night for 30 da. Find the cost of the water used, at 35¢ per 100 cu. ft.



4. The motor on Mrs. Hall's washing machine is run by water from a $\frac{1}{2}$-inch faucet wide open. At 35¢ per 100 cu. ft., how much does it cost to run the washing machine $2\frac{1}{2}$ hr.? To run an electric motor would cost 6¢ for $2\frac{1}{2}$ hr. How much would Mrs. Hall save if she used an electric motor?

5. Mrs. Hall went away for 11 hr. and left a $\frac{1}{2}$-inch faucet running half open. How many gallons of water were wasted? Find the cost, at 35¢ per 100 cu. ft.

6. A leak in a cellar wasted 1 gal. of water an hour. How much did this cost in a year, at 35¢ per 100 cu. ft.?

AN AUTOMOBILE TRIP

Mr. Wright and five scouts are driving from New York to Niagara Falls. They find these routes in a book:

ROUTE 26: *New York to Niagara Falls*

MILES FROM NEW YORK	
0.0	New York
151.7	Albany
244.9	Utica
296.0	Syracuse
340.4	Geneva
452.0	Buffalo
478.8	Niagara Falls

ROUTE 27: *Niagara Falls to Rochester*

MILES FROM NIAGARA FALLS	
0.0	Niagara Falls
23.0	Lockport
37.2	Middleport
42.5	Medina
53.4	Albion
68.5	Brockport
88.2	Rochester

ROUTE 28: *Rochester to New York*

MILES FROM ROCHESTER	
0.0	Rochester
80.0	Watkins
138.1	Owego
158.9	Binghamton
258.8	Monticello
328.1	Ramsey
349.0	New York

1. The scouts go by Route 26. Make a table showing the distance from each town to the next on this route.

2. They return by way of Rochester, using Routes 27 and 28. Make a table combining Routes 27 and 28 so that all the distances read from Niagara Falls. To do this, add 88.2 mi. to every distance now given in Route 28

3. Make a table like that in ex. 1 to show the distances between the towns in Routes 27 and 28.

4. What is the total distance from New York to Niagara Falls and return along the routes selected?

5. How much longer is the trip to Niagara Falls than the trip back along the routes selected?

6. Mr. Wright's car averages 16.8 mi. on 1 gal. of gasoline. How many gallons, to the nearest whole gallon, are needed for the trip from New York to Albany?

7. When the scouts leave Syracuse, on the way to Niagara, they have to make a detour because the road is being repaired. When they reach Buffalo, they find that they have gone 176.8 mi. since leaving Syracuse. How many extra miles have they gone because of the detour?

8. If the speedometer reads 11,265 mi. when they leave New York and 12,294.1 mi. when they return, how many miles do they really travel? How much more is this than the total distance on Routes 26, 27, and 28?

9. It costs Mr. Wright 8.4¢ a mile to operate his car. The 5 scouts and Mr. Wright are each to pay $\frac{1}{6}$ of this cost. How much will each scout pay per mile?

10. Using the total distance found in ex. 8 and the cost per mile found in ex. 9, find, to the nearest cent, how much the transportation for the entire trip costs each scout. How much would it cost each scout to travel the same distance on the railroad at 3.6¢ a mile? How much does each scout save by going with Mr. Wright?

11. If the total driving time for the entire trip is 50.2 hr., what is the average rate of driving per hour?

DECIMALS

1. Which is longer, 14.9 ft. or 14.875 ft.?

Reduce to common fractions or to mixed numbers:

2. .35 **3.** .12½ **4.** 2.25 **5.** 4.625 **6.** .225

Reduce the following to decimals:

7. $\frac{1}{4}$ **8.** $\frac{5}{6}$ **9.** $\frac{3}{8}$ **10.** $\frac{7}{8}$ **11.** $\frac{2}{3}$

Multiply. Check the work by going over it again:

12. .057 × 7	**15.** 6.92 × 6.7	**18.** .049 × 5	**21.** 40.5 × 100
13. 4000 × .002	**16.** 8900 × 7.2	**19.** 1.9 × 800	**22.** 5.64 × .300
14. 195 × 10	**17.** 2.5 × 100	**20.** 326.7 × .08	**23.** .09 × 1000

Divide each of the following by 10, 100, *and* 1000:

24. 600 **25.** $50 **26.** 38 **27.** 9.4 **28.** .7

Divide. Check the work by multiplying:

29. .4)$\overline{.48}$	**32.** 7.9)$\overline{301.78}$	**35.** 5.6)$\overline{.18144}$
30. .8)$\overline{5.6}$	**33.** .73)$\overline{371.57}$	**36.** .83)$\overline{4913.6}$
31. .6)$\overline{.0282}$	**34.** .094)$\overline{89.582}$	**37.** .063)$\overline{242.55}$

Divide, annexing 0*'s to the dividend. If the quotient does not come out exact, carry it to three decimal places and find the answer to the nearest hundredth:*

38. 24)$\overline{188}$	**41.** 56)$\overline{402}$	**44.** 5.6)$\overline{332}$
39. 75)$\overline{186}$	**42.** 8.7)$\overline{94.5}$	**45.** 46)$\overline{4439}$
40. 28)$\overline{194.6}$	**43.** .28)$\overline{14.92}$	**46.** 93)$\overline{439.9}$

REVIEW OF FRACTIONS

Add. Check the work by going over it:

1. $3\frac{1}{8}$	**2.** $6\frac{3}{4}$	**3.** $9\frac{1}{2}$	**4.** $2\frac{2}{3}$	**5.** $2\frac{5}{10}$	**6.** $8\frac{1}{4}$
$4\frac{5}{8}$	$2\frac{1}{2}$	$3\frac{5}{8}$	$3\frac{1}{6}$	$9\frac{1}{10}$	$9\frac{1}{2}$
$7\frac{3}{8}$	$5\frac{1}{4}$	$4\frac{3}{4}$	$1\frac{1}{2}$	$6\frac{1}{2}$	$2\frac{5}{12}$
7. $5\frac{3}{8}$	**8.** $3\frac{2}{3}$	**9.** $1\frac{1}{4}$	**10.** $9\frac{7}{10}$	**11.** $2\frac{5}{8}$	**12.** $5\frac{5}{6}$
$7\frac{1}{2}$	$\frac{1}{2}$	$6\frac{3}{5}$	$8\frac{3}{5}$	$6\frac{1}{12}$	$4\frac{3}{4}$
$9\frac{7}{16}$	$2\frac{1}{3}$	$4\frac{3}{4}$	$9\frac{2}{5}$	$2\frac{1}{4}$	$\frac{2}{3}$
$4\frac{3}{8}$	$\frac{3}{4}$	$\frac{4}{5}$	$7\frac{1}{2}$	$1\frac{2}{3}$	$5\frac{1}{3}$

Subtract. Check the work by going over it:

13. $8\frac{7}{16}$	**14.** $5\frac{1}{8}$	**15.** 6	**16.** 9	**17.** $7\frac{3}{4}$	**18.** $4\frac{1}{2}$
$3\frac{1}{16}$	$4\frac{7}{8}$	$2\frac{3}{4}$	$8\frac{5}{8}$	$3\frac{1}{2}$	$2\frac{3}{8}$
19. $6\frac{1}{4}$	**20.** $7\frac{1}{5}$	**21.** $3\frac{1}{6}$	**22.** $7\frac{3}{4}$	**23.** $9\frac{3}{10}$	**24.** $8\frac{1}{2}$
$3\frac{5}{8}$	$5\frac{3}{10}$	$\frac{1}{2}$	$4\frac{1}{3}$	$5\frac{1}{2}$	$1\frac{9}{16}$

Multiply. In the answers for ex. 33 to 36, *call a fraction of a cent another cent:*

25. $\frac{5}{8}\times\frac{1}{2}$	**29.** $12\times\frac{7}{16}$	**33.** $9\times\$.37\frac{1}{2}$
26. $\frac{7}{16}\times\frac{4}{5}$	**30.** $3\frac{1}{4}\times\frac{1}{2}$	**34.** $3\frac{5}{8}\times\$2.40$
27. $\frac{3}{4}\times 18$	**31.** $6\frac{1}{4}\times 3\frac{1}{5}$	**35.** $1\frac{3}{4}\times\$1.50$
28. $3\times 11\frac{3}{4}$	**32.** $12\frac{1}{2}\times 16\frac{2}{3}$	**36.** $5\frac{1}{2}\times\$1.73$

Divide. Check the work by going over it:

37. $\frac{1}{2}\div 2$	**41.** $\frac{9}{8}\div\frac{6}{5}$	**45.** $4\frac{1}{2}\div 6$
38. $\frac{3}{4}\div 6$	**42.** $28\div\frac{1}{4}$	**46.** $5\frac{1}{4}\div 7$
39. $\frac{7}{8}\div\frac{1}{2}$	**43.** $1\frac{7}{8}\div\frac{3}{4}$	**47.** $7\frac{1}{2}\div 2\frac{1}{2}$
40. $\frac{5}{12}\div\frac{3}{8}$	**44.** $15\div 3\frac{1}{7}$	**48.** $4\frac{3}{8}\div 3\frac{1}{2}$

HOW CAN THESE PROBLEMS BE SOLVED?

1. Dick knows how long he takes to walk a mile and how many miles it is to the village. How can he tell how long he will take to walk to the village?

2. Mabel knows how many people will be at her birthday party and how much ice cream costs per quart. If she plans to serve 6 people with each quart, how can she find how much all the ice cream will cost?

3. Hilda knows the amount of money she had in the savings bank on January 1 and the amounts she deposited and withdrew during January. Tell her how to find what amount she should have in the bank on January 31.

4. Hazel is planning to stay at a camp 6 wk. next summer. She knows the railroad fare and the weekly rate at camp. How can she find the total expense?

5. A number of boys are planning to rent a canoe for 5 wk. next summer. If they know the rate per week, how can they find each boy's share in the rent of the canoe?

6. Al works afternoons at 35¢ an hour. He keeps a record of the time he arrives at work and the time he leaves. How can he find his week's earnings?

7. At Easter time Wilda colored $3\frac{1}{2}$ doz. Easter eggs. She knows the cost of the dye she used and the cost of the eggs per dozen. How can she find the total expense for the Easter eggs?

8. Mrs. Adams knows how many cups of sugar she needs for jelly and how much sugar costs per pound. Counting 2 cups to a pound, how can she find the cost of the sugar for the jelly?

CHAPTER IV

STUDYING A BILL

A storekeeper often lets a reliable customer open an *account* with him and *charge* the things bought at his store. At the end of the month he sends a *bill* showing how much the customer owes him. When the bill is paid, the storekeeper *receipts* it. Here is a typical bill:

JONES, KING, AND COMPANY
Clothiers

Chicago, Nov. 1, 19—

Mr. Charles Reed
893 Beech St.
Chicago

Oct.	2	4 Neckties	@ .85	3	40		
	10	6 Collars	@ .25	1	50		
	15	2 Pairs Gloves	@2.10	4	20		
	24	1 Boys' Suit	@16.50	16	50		
						25	60

Received Payment
Nov. 4, 19—
JONES, KING, AND COMPANY
per M.K.

The sign @ means "at." The total charge for each item, such as the $3.40 for neckties, is an *extension*. $25.60 is the *total amount*. When was this bill receipted? by whom?

A bill should give these facts: (1) the place and the date; (2) the merchant's name; (3) the customer's name; (4) the date, the quantity, the price, and the extension for each item; (5) the total amount of the bill.

MAKING OUT BILLS

Make out and receipt bills for the following. Make up the names, the addresses, and the dates:

1. $2\frac{3}{4}$ doz. eggs @ 56¢; $3\frac{1}{2}$ lb. sweet butter @ 64¢; $1\frac{3}{4}$ lb. Swiss cheese @ 60¢; 2 pt. cream @ 35¢.

2. 1 boys' mackinaw overcoat @ $7.45; 2 ties @ $.95; 3 pr. boys' sport hose @ $1.25; 1 cap @ $2.15.

3. $2\frac{1}{2}$ doz. rolls @ 15¢; 4 loaves bread @ 9¢; $1\frac{3}{4}$ doz. buns @ 18¢; 3 doz. cookies @ 20¢.

4. $6\frac{1}{2}$ lb. chicken @ 52¢; $1\frac{1}{4}$ lb. sausage @ 42¢; $2\frac{3}{4}$ lb. steak @ 60¢; $3\frac{1}{2}$ lb. lamb chops @ 50¢.

5. 1 wheelbarrow @ $4.25; 2 axes @ $1.18; 1 garden hose @ $14.60; 16 lb. nails @ $.12; 5 bolts @ $.35.

6. 5 tennis balls @ $.85; 2 pr. sport hose @ $1.15; 2 catchers' mitts @ $2.90; 1 football @ $6.75; 2 tennis rackets @ $3.75.

7. $\frac{1}{2}$ doz. linen handkerchiefs @ $3.50; 2 pr. kid gloves @ $2.55; 2 pr. woolen blankets @ $6.98; 7 Turkish towels @ $.49.

8. 1 tool chest @ $9.65; 2 pr. pliers @ $.42; 1 steel hammer @ $.65; 3 chisels @ $.68.

9. 2 Axminster rugs @ $20.95; 15 sq. yd. printed linoleum @ $1.56; 11 yd. curtain goods @ $.75.

10. 3 jars strawberry jam @ 35¢; 5 packages buckwheat flour @ 25¢; 6 packages crackers @ 15¢.

11. 2 bottles tomato catsup @ 24¢; 3 jars olives @ 26¢; $2\frac{1}{2}$ lb. walnuts @ 43¢; 4 cans peaches @ 39¢.

12. $5\frac{1}{2}$ yd. cotton crêpe @ 48¢; 3 spools sewing silk @ 12¢; $11\frac{1}{2}$ yd. braid @ 35¢; $2\frac{3}{4}$ yd. ribbon @ 39¢.

SHOWING CREDITS IN BILLS

Sometimes the *charges* on monthly bills are placed in one column and the *credits* in the next column. If a payment is made during the month or if some article is returned, the merchant gives *credit* for these items.

WARREN BROTHERS
Athletic Goods

Dick Rankin, Baseball Manager
Roosevelt School,
Flint, Mich.

Detroit, Apr. 30, 19~

Date		Items		Charges		Credits	
Apr	2	9 gray baseball suits	@ 5.50	49	50		
	6	6 pr. baseball shoes	@ 3.25	19	50		
	6	By cash on account				25	00
	8	3 catchers' mitts	@ 1.50	4	50		
	11	1 catchers' mitt returned	@ 1.50			1	50
				73	50	26	50
			Credit	26	50		
			Balance	47	00		

The total charges above are $73.50; the total credits are $26.50. Hence the *balance* due is $47.00.

Exercises

Make out bills for these items. Supply names and dates:

1. 3 scout hats @ $1.60; 6 scout handkerchiefs @ 25¢; credit, 1 scout hat @ $1.60 returned; 2 sweaters @ $7.00; 2 khaki middy blouses @ $1.75; 3 pr. stockings @ $.55; credit, 1 sweater @ $7.00 returned.

2. 1 small Chinese rug @ $49.50; cash on account, $25.00; 3 chairs @ $6.76; 2 lamps @ $18.75; 1 table @ $24.80; 2 tablecloths @ $2.85.

MAKING OUT RECEIPTS

You have seen how a bill is receipted. Sometimes, if no bill is presented, a separate receipt is written to show that one person has received money from another.

Buffalo, N. Y. April 10, 19–

$16.25

Received from George Miller

Sixteen and 25/100 Dollars

for repairing automobile

John Harris

Supply the dates and the names of cities:

1. Bob Dugan sold George Price his bicycle for $13.50. Write the receipt which Bob gave George.

2. Esther paid her dentist, Dr. J. M. Green, $3.50 for filling her tooth. Write a receipt for this.

3. Mr. Rex bought a car for $2500 from the Monroe Company. He paid $700 cash. Write a receipt for this payment.

4. Mrs. Fuller pays her landlord, Mr. Greeley, $50 rent each month. Make out the rent receipt which Mrs. Fuller receives from Mr. Greeley for rent for March.

Write a receipt for each. Supply names and dates:

5. $50 for building a garage.

6. $10 for the rent of a tent for one month.

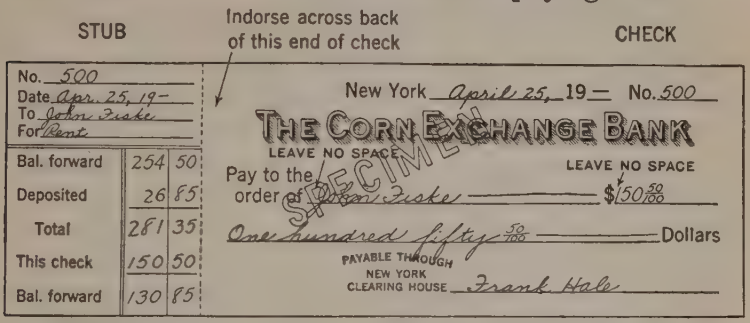
7. $3.60 for milk for August.

8. $15 for the first payment on a radio set.

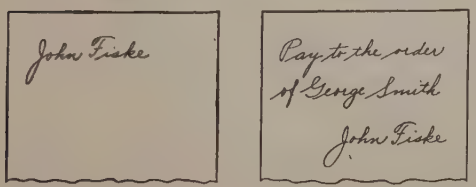
9. $4.75 for a telephone bill for January.

HOW TO WRITE CHECKS ON A BANK

Many people keep their money in a bank. By writing a **check,** they may order the bank to pay some of their money to the person named in the check. Checks are usually more convenient than cash for paying bills.



1. Who wrote the above check?
2. In what bank does Mr. Hale have his money?
3. To whom are the words " Pay to " addressed?
4. To whom is the bank ordered to pay the money?
5. Why is the amount written in words and also in figures? Why is a waved line put after the amount written in words? after John Fiske's name?
6. When Mr. Fiske wishes *to cash* the check, he *indorses* it by writing his name across the back on the left-hand end, as in *A*, thus acknowledging receipt of the money. If he wishes the check paid to George Smith, he indorses it as in *B*.



KEEPING ACCOUNT OF OUR BANK BALANCE

The stub of a check, which should be filled out when the check is written, gives a record of each payment and shows the balance in the bank. It stays in the check book when the check is torn out.

Here are six of Mr. Dow's stubs.

1. Study stub No. 77; then tell what numbers should be put in place of the stars on stubs No. 78, 79, 80, 81, and 82.

No. 77		
Date Jan. 3, 19~		
To Carl Green		
For Auto repairs		
Bal. for'd	154	50
Deposited	30	00
Total	184	50
This check	27	75
Bal. for'd	156	75

No. 78		
Date Jan. 5, 19~		
To Paul Jones		
For Rent		
Bal. for'd	156	75
Deposited	00	00
Total	156	75
This check	83	27
Bal. for'd	*	

No. 79		
Date Jan. 6, 19~		
To John Holt		
For Groceries		
Bal. for'd	*	
Deposited	84	60
Total	*	
This check	36	89
Bal. for'd	*	

No. 80		
Date Jan. 7, 19~		
To Will White		
For Cement walk		
Bal. for'd	*	
Deposited	00	00
Total	*	
This check	42	78
Bal. for'd	*	

No. 81		
Date Jan 9, 19~		
To Ellris Company		
For Tires		
Bal. for'd	*	
Deposited	23	17
Total	*	
This check	27	00
Bal. for'd	*	

No. 82		
Date Jan. 9, 19~		
To Dr. Grant		
For services to date		
Bal. for'd	*	
Deposited	45	00
Total	*	
This check	31	22
Bal. for'd	*	

2. On what days did Mr. Dow put money in the bank?

3. If Mr. Dow had wanted to write a check for $187.93 on Jan. 9, could he have done it? Why not?

4. Suppose that you are a storekeeper. Make out bills against 5 pupils in your class. Have each pay his bill by check. Accept the checks only if they are made out right.

IMPROVEMENT TEST No. 18

Test 18 A — Reduction (Time 4 min. after copying)

Change to common fractions in lowest terms:

1. .24 **2.** .35 **3.** .37$\frac{1}{2}$ **4.** .050 **5.** .036

6. .60 **7.** .06 **8.** .12$\frac{1}{2}$ **9.** .075 **10.** .875

Change to exact decimals:

11. $\frac{9}{20}$ **12.** $\frac{3}{8}$ **13.** $\frac{4}{5}$ **14.** $\frac{21}{25}$ **15.** $\frac{13}{50}$

Test 18 B — Reduction (Time 4 min. after copying)

Change to decimals, correct to the nearest hundredth:

1. $\frac{4}{7}$ **2.** $\frac{5}{12}$ **3.** $\frac{7}{12}$ **4.** $\frac{9}{16}$

5. $\frac{8}{9}$ **6.** $\frac{5}{32}$ **7.** $\frac{4}{15}$ **8.** $\frac{13}{36}$

Test 18 C — Multiplication (Time 4 min. after copying)

1. 64 × .12	**2.** 28.7 × 1.2	**3.** 3000 × .003	**4.** 2940 × .41
5. 273 × .28	**6.** 39.6 × .07	**7.** .0653 × 9	**8.** 37.00 × .52
9. .036 × .36	**10.** 419 × .006	**11.** .0009 × .05	**12.** .108 × 800

Test 18 D — Division (Time 4 min. after copying)

1. 5.4)$\overline{.18414}$ **2.** .81)$\overline{33858}$ **3.** 4.6)$\overline{24.472}$

BUYING BY PARCEL POST

Packages may be sent through the mail by **parcel post.** The amount of postage depends on the weight of the package and on the distance it is sent. All places within 50 mi. of a post office are in Zone 1; all those from 51 mi. to 150 mi. away are in Zone 2, etc. The table below shows the rate for each zone. The map on page 271 shows how the zones are marked from Philadelphia. Any fraction of a pound is counted as an extra pound. Thus, $3\frac{1}{4}$ lb. is counted as 4 lb.

WEIGHT	ZONES						
	1 AND 2	3	4	5	6	7	8
	1 MI. TO 150 MI.	151 MI. TO 300 MI.	301 MI. TO 600 MI.	601 MI. TO 1000 MI.	1001 MI. TO 1400 MI.	1401 MI. TO 1800 MI.	ALL OVER 1800 MI.
First pound	7¢	8¢	8¢	9¢	10¢	12¢	13¢
Each additional pound	1¢	2¢	4¢	6¢	8¢	10¢	12¢

Exercises

In the following the distances are figured from Philadelphia. Use the map on page 271 *to find the zone in which each city is located.*

1. Find the cost of sending a 14-pound package from Philadelphia to Richmond, Va., in Zone 3.

For Zone 3, the first pound costs 8¢; the 13 additional pounds cost 2¢ each, or 26¢. Find the total cost.

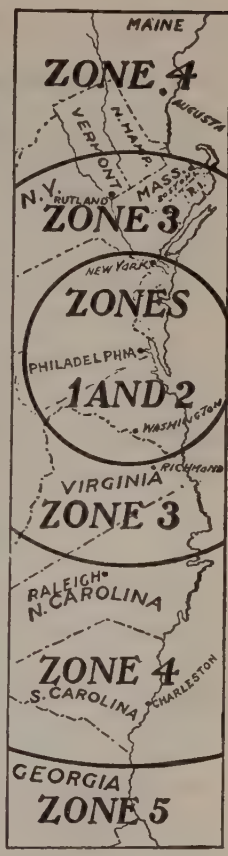
2. A farmer near Washington, D. C., sends a package of eggs weighing 8 lb. to a man in Philadelphia. How much does he pay for postage?

3. A girl in Raleigh, N. C., orders a lamp costing $17.65 from Philadelphia. The shipping weight is 18 lb. and the postage is extra. How much money should she send for the lamp and the postage?

4. How much will it cost to send from Philadelphia to Augusta, Maine, a tennis racket weighing 2 lb.? a package of books weighing 18 lb.?

5. George can buy pure Vermont maple sugar in Rutland, Vt., for 24¢ a pound. It costs him 38¢ a pound in Philadelphia, where he lives. How much will he save after paying the postage if he sends to Rutland for 10 lb. of maple sugar?

6. Paul sends from Charleston, S. C., to Philadelphia for the following articles: baseball bat, $2\frac{1}{4}$ lb.; glove, 8 oz.; baseball, 8 oz.; mask, $1\frac{1}{2}$ lb.; uniform, 3 lb.; shoes, $2\frac{1}{2}$ lb. How much postage must he send for the entire package?



Find the cost of mailing the following packages:

7. 17 lb. to Zone 8

8. $5\frac{3}{4}$ lb. to Zone 6

9. $11\frac{5}{8}$ lb. to Zone 7

10. 20 lb., 900 miles

11. $7\frac{1}{4}$ lb., 280 miles

12. $3\frac{1}{2}$ lb., 1900 miles

13. Using the map above, make up five parcel-post problems. Use Philadelphia as one of the cities in each problem.

PERCENTAGE

A New Way to Write Hundredths

You have learned in your work in decimals that .37 is a short way of writing $\frac{37}{100}$. Another way to write $\frac{37}{100}$ is 37%, which is read *37 per cent.* *Per cent* means *hundredths.* The sign % stands for *per cent.*

You can now write hundredths in these four ways:

$$\frac{37}{100} = .37 = 37\% = 37 \text{ per cent}$$

Similarly, $\frac{6}{100} = .06 = 6\% = 6$ per cent

This new method of writing hundredths is called **percentage.** It is used every day in business and is often found in newspapers and magazines.

How Per Cents Are Used

1. If 96% of the 450 pupils in our school were present yesterday, how many pupils were present?

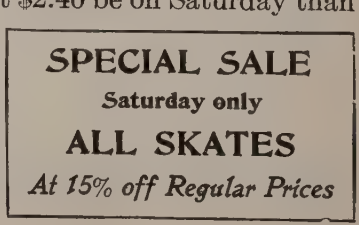
This means that $\frac{96}{100}$ of 450 pupils were present yesterday. Another way to write $\frac{96}{100}$ of 450 is .96×450. Hence 96% of 450 means .96×450.

Multiplying 450 by .96, you find that 432 pupils were present yesterday.

```
  450
  .96
 27 00
405 0
------
432.00
```

2. Sarah sees this sign in a store. How much cheaper will skates which regularly cost $2.40 be on Saturday than on other days?

The amount "taken off" the price on Saturday is 15% of $2.40, which means .15 × $2.40, or $.36. Hence on Saturday the skates will be $.36 cheaper than on other days.



USING DECIMALS IN PERCENTAGE PROBLEMS

In percentage there are no new rules for adding, subtracting, multiplying, or dividing, because percentage problems are worked by changing the per cents to decimals.

Exercises

Write each of the following as a decimal:

1. 17%	**5.** 1%	**9.** $\frac{55}{100}$	**13.** $\frac{70}{100}$
2. 23%	**6.** 90%	**10.** $\frac{98}{100}$	**14.** $\frac{6}{100}$
3. 36%	**7.** 7%	**11.** $\frac{76}{100}$	**15.** $\frac{5}{100}$
4. 45%	**8.** 9%	**12.** $\frac{1}{100}$	**16.** $\frac{9}{100}$

17. 2 per cent **19.** 95 per cent

18. 83 per cent **20.** 60 per cent

Write each of these as a per cent, using the sign %:

21. .63	**24.** .01	**27.** $\frac{45}{100}$	**30.** $\frac{9}{100}$
22. .24	**25.** .05	**28.** $\frac{76}{100}$	**31.** $\frac{1}{100}$
23. .40	**26.** .07	**29.** $\frac{80}{100}$	**32.** $\frac{6}{100}$

33. You learned on page 272 that 96% of 450 means $.96 \times 450$. What does 96% of 868 mean?

Tell what numbers should be put in place of the dots:

34. 54% of 250 means $.54 \times 250$, which equals 135.

35. 15% of 620 means . . . $\times 620$, which equals . . .

36. 8% of 150 means $.08 \times 150$, which equals . . .

37. 4% of 425 means . . . $\times 425$, which equals . . .

38. 1% of 900 means . . . $\times 900$, which equals . . .

39. 5% of 60 means . . . $\times$ . . ., which equals . . .

40. 32% of 75 means . . . $\times$ . . ., which equals . . .

LEARNING THE LANGUAGE OF PERCENTAGE

In studying percentage, you are learning a new kind of language, which business men use every day for talking about *hundredths*. Read each problem carefully to be sure that you understand this new language.

1. Lola received a mark of 85% on a spelling test of 40 words. What decimal part of the test had she right? How many words did she have right?

2. Will's arithmetic test was marked 65%. What does this mean? If there were 20 examples on the test, how many did Will get right?

3. In a spelling test of 50 words, the marks of some of the pupils were as follows: Alice, 98%; George, 86%; Fred, 74%; Tony, 68%; Marion, 92%; Julia, 94%. How many words did each of these pupils get right?

4. The Stars played 25 baseball games and won 76% of them. How many games did they win?

5. The principal said that 18% of the 350 children in the Walker School were underweight. What did he mean by that? How many children were underweight?

6. Tom's older brother saves 15% of all he earns. How much does he save in a year if he earns $1000 a year? if he earns $1200 a year?

7. Mrs. Cox gets 5% off on a gas bill of $2.40 for paying it promptly. How much reduction does she get?

8. Of the 5225 children in the Waterville schools, 68% have money in the School Savings Bank. How many of the children have money in the bank?

9. The wages in a machine factory were increased 5%. What does this mean? If a man earned $5.00 a day before the increase, how much more will he get now?

10. On a spelling test of 100 words, Roy spelled 89 words correctly. Sarah said that he got $\frac{89}{100}$ of the test right. Say this in percentage language.

11. Joe is trying to save 35¢ out of every dollar he earns. What part of each dollar will he save? Say this in percentage language.

12. Albert sorted apples before packing them in a barrel. He found, on an average, 7 bad apples in every 100 apples. What part of each 100 apples was bad? Say this in percentage language.

13. The school superintendent found that .87 of the pupils in his city had not been absent or tardy for six months. Say this in percentage language.

14. Mr. Law raises chickens. He says that 73% of the eggs which he put in the incubator hatched. What does this mean? What other fact do you need to know if you wish to find out how many eggs hatched?

Tell what each of these statements means:

15. Milk is about 87% water.

16. Good milk contains as much as 5% butter fat.

17. Kansas produces 13% of our wheat supply.

18. About 45% of the world's gold comes from Africa.

19. The population of the United States is about 7% of the population of the entire world.

20. Dick bought an overcoat marked "85% wool."

21. Esther bought a sweater at a reduction of 20%.

EXERCISES IN FINDING PER CENTS

Find each of the following per cents:

1. 56% of 25	**12.** 5% of $300	**23.** 6% of 950
2. 35% of 80	**13.** 85% of $40	**24.** 35% of 680
3. 65% of 60	**14.** 24% of $75	**25.** 45% of 480
4. 68% of 50	**15.** 7% of $350	**26.** 7% of 8500
5. 56% of 75	**16.** 6% of $240	**27.** 85% of 1320
6. 2% of 850	**17.** 3% of $754	**28.** 82% of 7750
7. 5% of 360	**18.** 9% of $198	**29.** 5% of 12,460
8. 8% of 250	**19.** 76% of $355	**30.** 1% of 93,500
9. 5% of 240	**20.** 93% of $298	**31.** 9% of 18,500
10. 6% of 150	**21.** 16% of $258	**32.** 3% of 65,900
11. 8% of 825	**22.** 85% of $298	**33.** 76% of 19,350

34. In Reed City, 92% of the 25,850 schoolchildren were promoted. How many children were promoted?

35. Mrs. Day plans to buy on the installment plan furniture which costs $159.70. The clerk offers her a reduction of 8% if she will pay the total amount in cash. How much will she save by paying cash?

Since 8% of 159.70 means .08×159.70, multiply as shown here. The result is $12.776, which, to the nearest cent, is $12.78.

$$\begin{array}{r} \$159.70 \\ .08 \\ \hline \$12.7760 \end{array}$$

Mrs. Day will save $12.78 by paying cash.

Find each answer correct to the nearest cent:

36. 1% of $258.85	**40.** 31% of $998.60
37. 2% of $217.60	**41.** 65% of $250.90
38. 5% of $440.50	**42.** 11% of $500.75
39. 12% of $985.55	**43.** 93% of $233.60

A SHORT WAY TO FIND 25% OF A NUMBER

1. Since 25% of 160 means .25 of 160, you may find 25% of \$160 by multiplying \$160 by .25. This gives \$40 as the result.

2. You know also that $25\% = \frac{25}{100}$, which can be reduced to $\frac{1}{4}$. Hence $25\% = \frac{1}{4}$. Instead of finding 25% of \$160 by multiplying \$160 by .25, you can get the same answer in a shorter way by taking $\frac{1}{4}$ of \$160.

\$160
.25
8 00
32 0
\$40.00

4)\$160
\$ 40

3. In the same way, $50\% = \frac{50}{100}$, which can be reduced to $\frac{1}{2}$; hence $50\% = \frac{1}{2}$. Similarly, $75\% = \frac{75}{100} = \frac{3}{4}$.

4. *Remember these short cuts:*

25% of anything is the same as $\frac{1}{4}$ of it.
50% of anything is the same as $\frac{1}{2}$ of it.
75% of anything is the same as $\frac{3}{4}$ of it.

Exercises

1. On an arithmetic test Benjamin received a mark of 50%. If there were 16 problems in the test, how many did Benjamin get right?

2. Eleanor got $\frac{3}{4}$ of her problems right to-day. What per cent was her paper marked?

3. Mr. Benson buys an automobile for \$1200. He pays 50% cash when he gets the car and the balance in monthly installments. How much cash does he pay?

4. Two stores were selling basket balls at the same price. One store now advertises them at " 25% less than regular price." The other store offers them at " $\frac{1}{4}$ off." Which store offers the better bargain?

USING THE SHORT CUTS

1. The motor on a new Kent car gives 25% more power than last year's model. If the old motor was 32 horse power, what is the horse power of the new motor?

2. India produces about $\frac{1}{4}$ of the world's crop of cane sugar. Say this in percentage language.

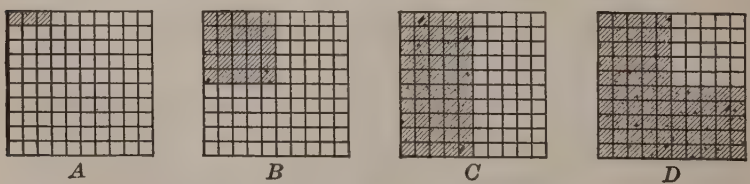
3. Jane was marked 75% on a spelling test of 60 words. How many words did she have right?

4. Jerry and Frank decide to share the expenses of a camping trip "fifty-fifty." What does this mean? Say it in percentage language.

Use the short cuts to find the following:

5. 25% of 64	**10.** 25% of \$1.64	**15.** 75% of \$3.60
6. 50% of 80	**11.** 25% of \$5.20	**16.** 50% of \$2.87
7. 75% of 76	**12.** 75% of \$8.48	**17.** 75% of \$4.56
8. 25% of 48	**13.** 50% of \$5.00	**18.** 25% of \$1.25
9. 75% of 40	**14.** 50% of \$1.35	**19.** 25% of \$2.70

20. Into how many small squares is A divided? Each small square is what part of A? what per cent of A?



21. $\frac{1}{4}$ of B is shaded. By counting the small squares in the shaded part, show that $\frac{1}{4} = \frac{25}{100} = 25\%$.

22. In C, show that $\frac{1}{2} = \frac{50}{100} = 50\%$.

23. In D, show that $\frac{3}{4} = \frac{75}{100} = 75\%$.

A SHORT WAY TO FIND 10% OR 20% OF A NUMBER

1. Louis, the treasurer of the athletic association, says that 10% of the 130 members have not paid their dues. How many have not yet paid?

$10\% = \frac{10}{100}$, which can be reduced to $\frac{1}{10}$. Therefore $10\% = \frac{1}{10}$. A short way to find 10% of 130 is to take $\frac{1}{10}$ of 130, which gives 13.

2. Prove the following by changing each per cent to a fraction and reducing the fraction to lowest terms. Then memorize them:

$10\% = \frac{1}{10}$	$30\% = \frac{3}{10}$	$60\% = \frac{3}{5}$
$20\% = \frac{1}{5}$	$40\% = \frac{2}{5}$	$80\% = \frac{4}{5}$

3. About 10% of the inhabitants of Missouri live in Kansas City. Say this in another way.

4. Jack earns \$15 a week. If his salary is increased 20%, how much more will he earn each week?

5. About $\frac{4}{5}$ of the moving pictures made in America are also used abroad. Say this in another way.

Use the short cuts to find the following per cents:

6. 10% of 70	**13.** 60% of 280	**20.** 10% of \$1.30
7. 20% of 45	**14.** 40% of 260	**21.** 20% of \$9.85
8. 60% of 85	**15.** 20% of 800	**22.** 10% of \$0.60
9. 40% of 45	**16.** 30% of 580	**23.** 40% of \$8.50
10. 20% of 15	**17.** 10% of 240	**24.** 20% of \$6.70
11. 10% of 20	**18.** 10% of 550	**25.** 10% of \$0.40
12. 20% of 95	**19.** 60% of 780	**26.** 80% of \$0.75

MORE SHORT CUTS IN FINDING PER CENTS

1. Nat saw this advertisement in a magazine. What does it mean?

BOYS' SUITS
BUY DIRECTLY FROM THE FACTORY
AND
SAVE $33\frac{1}{3}\%$
BOSTON SUIT COMPANY

$33\frac{1}{3}\% = \frac{33\frac{1}{3}}{100}$, which may be changed to a smaller fraction in this way:

$$\frac{33\frac{1}{3}}{100} = \frac{33\frac{1}{3}\times 3}{100\times 3} = \frac{100}{300} = \frac{1}{3}$$

Hence to save $33\frac{1}{3}\%$ of the price means to save $\frac{1}{3}$ of it.

2. You often see $66\frac{2}{3}\%$ and $12\frac{1}{2}\%$ in advertisements. These per cents are changed to fractions in this way:

$$66\tfrac{2}{3}\% = \frac{66\frac{2}{3}}{100} = \frac{66\frac{2}{3}\times 3}{100\times 3} = \frac{200}{300} = \frac{2}{3} \qquad 12\tfrac{1}{2}\% = \frac{12\frac{1}{2}}{100} = \frac{25}{200} = \frac{1}{8}$$

3. *Memorize the following:*

$33\frac{1}{3}\% = \frac{1}{3}$	$16\frac{2}{3}\% = \frac{1}{6}$	$12\frac{1}{2}\% = \frac{1}{8}$	$62\frac{1}{2}\% = \frac{5}{8}$
$66\frac{2}{3}\% = \frac{2}{3}$	$83\frac{1}{3}\% = \frac{5}{6}$	$37\frac{1}{2}\% = \frac{3}{8}$	$87\frac{1}{2}\% = \frac{7}{8}$

Exercises

1. Ida got $\frac{2}{3}$ of the examples on a test right. What per cent should her paper be marked?

2. Hugh bought a bicycle for $27.75. After several months he sold it to Bill for $66\frac{2}{3}\%$ of what he had paid for it. How much did Bill pay?

3. Show how to change $16\frac{2}{3}\%$ to $\frac{1}{6}$. Show also how to change $37\frac{1}{2}\%$ to $\frac{3}{8}$ and $62\frac{1}{2}\%$ to $\frac{5}{8}$.

4. Show how to change $83\frac{1}{3}\%$ to $\frac{5}{6}$ and $87\frac{1}{2}\%$ to $\frac{7}{8}$.

IMPORTANT PRODUCTS OF THE WORLD

1. Jack reads that $33\frac{1}{3}\%$ of the 10,770,000 bu. of flaxseed produced annually in this country comes from Minnesota. Say this in another way. How many bushels of flaxseed does Minnesota produce annually?

2. Mexico produced $37\frac{1}{2}\%$ of the \$146,000,000 worth of silver produced in the world one year. Find the value of Mexico's silver output that year.

3. Brazil produced $12\frac{1}{2}\%$ of the world's rubber supply one year. If the whole world produced 600,000,000 lb. of rubber that year, how much did Brazil produce?

4. The United States produced 11,000,000 bales of cotton one year. If $16\frac{2}{3}\%$ of this amount came from North Carolina and South Carolina together, how many bales did these two states produce that year?

Finding Per Cents by Short Cuts

Find $33\frac{1}{3}\%$, $66\frac{2}{3}\%$, *and* $16\frac{2}{3}\%$ *of each number:*

1. 72	**4.** 234	**7.** 444	**10.** \$3.42	**13.** \$2.88
2. 96	**5.** 282	**8.** 270	**11.** \$2.28	**14.** \$4.35
3. 84	**6.** 156	**9.** 516	**12.** \$4.98	**15.** \$6.27

Find $12\frac{1}{2}\%$, $37\frac{1}{2}\%$, $62\frac{1}{2}\%$, *and* $87\frac{1}{2}\%$ *of each:*

16. 64	**19.** 192	**22.** 344	**25.** \$4.64	**28.** \$6.24
17. 96	**20.** 312	**23.** 840	**26.** \$5.36	**29.** \$10.00
18. 56	**21.** 168	**24.** 608	**27.** \$2.32	**30.** \$15.92

Find the following per cents:

31. $33\frac{1}{3}\%$ of \$15.87

32. $16\frac{2}{3}\%$ of \$17.04

33. $66\frac{2}{3}\%$ of \$15.51

34. $12\frac{1}{2}\%$ of \$1540.80

35. $37\frac{1}{2}\%$ of \$1800.00

36. $87\frac{1}{2}\%$ of \$1555.50

ESTIMATING THE ANSWER IN PERCENTAGE

In percentage, you sometimes *estimate* an answer mentally to find out approximately what it will be.

Arthur wanted to know about how large 49% of \$240 is. Since 49% is almost 50%, or $\frac{1}{2}$, Arthur found $\frac{1}{2}$ of \$240 mentally and got \$120. Is \$120 more or less than the exact answer? Find the exact answer.

To estimate 34% of 90, find $\frac{1}{3}$ of 90, because 34% is close to $33\frac{1}{3}\%$, which equals $\frac{1}{3}$.

Exercises

1. How can you estimate 26% of \$400? Will the estimate be more or less than the exact answer?

2. Louise got a mark of 52% on a spelling test of 50 words. About how many words did she spell correctly?

3. Harvey heard that 19% of the 450 boys in his school failed in spelling. About how many boys failed?

Think of 19% as about 20%, which equals $\frac{1}{5}$.

First estimate the approximate answer for each problem. Then find the correct answer:

4. 51% of 200	**9.** 9% of 850	**14.** 76% of \$1.28
5. 19% of 150	**10.** 30% of 660	**15.** 11% of \$9.40
6. 17% of 360	**11.** 13% of 800	**16.** 18% of \$6.00
7. 74% of 880	**12.** 41% of 250	**17.** 52% of \$2.25
8. 89% of 500	**13.** 48% of 150	**18.** 12% of \$2.40

19. If 39% of the 1600 children in a school are underweight, how many are underweight?

Blanche thinks of 39% as nearly $37\frac{1}{2}\%$, or $\frac{3}{8}$, while Howard thinks of it as almost 40%, or $\frac{2}{5}$. How can you tell whose estimate will be closer to the exact answer?

A NEW WAY TO SPEAK ABOUT THE WHOLE OF ANYTHING

1. Ben was marked 100% on his arithmetic test. If there were 8 examples in the test, how many examples did he get right? What is 100% of 8 examples?

Since per cent means hundredths, $100\% = \frac{100}{100}$, or 1. Hence 100% of 8 examples means 1×8 examples, or 8 examples.

Ben got all 8 examples right.

$$\mathbf{100\% = \frac{100}{100} = 1 = \text{one unit} = \text{all} = \text{the whole}}$$

2. You see that 100% of anything means all of it.

100% of \$250 equals $1 \times \$250$, or *all of* \$250.

100% of a number means the entire number.

100% of a class means the whole class.

Exercises

1. The sign on this new building reads "100% fireproof." What does this mean? Are the walls of this building fireproof? the ceilings? the floors?

Tell what each of these means:

2. At a factory 100% of the workmen have savings bank accounts.

3. Ethel's dress is 100% wool.

4. 100% of the pupils in our class belong to the Red Cross.

Say each of these in percentage language:

5. All of our school attended the baseball game.

6. Laura had all the words in a spelling test right.

7. Beatrice attended school every day last term.

SUBTRACTING FROM 100%

1. Claude saved 25% of his salary last summer. What per cent of his salary did he spend?

All of Claude's salary is 100% of it. If he saved 25% of his salary, he spent 75% of it. You find 75% by subtracting 25% from 100%.

2. Sidney has 75% of his problems right. What per cent of them are wrong?

3. In Harriet's class, 20% of the children were absent during a storm. What per cent of them were present?

4. The Lang School won 65% of the baseball games they played. What per cent of the games did they lose?

5. If 90% of Miss Murray's class passed in arithmetic, what per cent of the class did not pass?

6. A blanket is guaranteed to be 75% camel's hair and the rest pure wool. What per cent of the blanket is wool?

7. In buying furniture Mrs. Blake agreed to pay 20% of the price in cash and the rest later. What per cent of the price did she pay later?

8. Edwin sold his sled for 10% less than it cost him. What per cent of the cost did he get for it?

9. Maud spends 50% of her allowance for lunches and 20% for car fare. If she saves the rest, what per cent of her allowance does she save?

10. In Ruth's class 24% of the pupils are underweight and 12% are overweight. What per cent of the class are the right weight?

11. India supplies 35% of the world's tea, China supplies 26%, and Ceylon supplies 25%. What per cent of the total supply of tea comes from the rest of the world?

IMPROVEMENT TEST No. 19

Test 19 A — Addition (Time 4 min.)

1	2.	3.	4.	5.
$6\frac{3}{8}$	$5\frac{3}{8}$	$9\frac{1}{2}$	$3\frac{3}{4}$	$6\frac{1}{6}$
$1\frac{1}{2}$	$2\frac{3}{4}$	$8\frac{3}{4}$	$2\frac{3}{5}$	$5\frac{1}{2}$
$\frac{1}{4}$	$1\frac{1}{2}$	$\frac{2}{3}$	$4\frac{1}{5}$	$4\frac{3}{4}$
$2\frac{3}{16}$	$8\frac{1}{2}$	$6\frac{1}{2}$	$1\frac{1}{10}$	$2\frac{5}{12}$

Test 19 B — Subtraction (Time 4 min.)

1.	2.	3.	4.
$1\frac{1}{2}$	9	$7\frac{1}{4}$	$6\frac{5}{16}$
$\frac{1}{3}$	$7\frac{5}{8}$	$2\frac{1}{5}$	$3\frac{3}{4}$
5.	**6.**	**7.**	**8.**
$8\frac{3}{4}$	7	$8\frac{1}{8}$	$9\frac{11}{12}$
$\frac{1}{3}$	$6\frac{1}{12}$	$5\frac{3}{4}$	$8\frac{1}{2}$
9.	**10.**	**11.**	**12.**
$2\frac{9}{10}$	8	$3\frac{1}{6}$	$9\frac{5}{8}$
$\frac{3}{5}$	$5\frac{7}{10}$	$1\frac{3}{4}$	$4\frac{1}{16}$

Test 19 C — Multiplication (Time 3 min. after copying)

1. $\frac{3}{8} \times \frac{1}{2}$	2. $5\frac{1}{6} \times 9$	3. $7 \times 62\frac{1}{2}$
4. $\frac{5}{6} \times \frac{3}{8}$	5. $9\frac{3}{4} \times 20$	6. $8\frac{5}{8} \times 48$
7. $\frac{3}{10} \times 55$	8. $2\frac{3}{4} \times 42$	9. $13\frac{1}{2} \times 1\frac{1}{3}$

Test 19 D — Division (Time 3 min. after copying)

1. $2\frac{1}{2} \div 5$	2. $5 \div \frac{3}{4}$	3. $2\frac{1}{4} \div \frac{3}{4}$
4. $1\frac{2}{3} \div 3$	5. $6 \div \frac{4}{5}$	6. $6\frac{1}{2} \div \frac{1}{4}$
7. $3\frac{3}{4} \div 10$	8. $9 \div 3\frac{3}{5}$	9. $1\frac{1}{4} \div 3\frac{1}{8}$

A NEW WAY TO SAY "THREE TIMES AS MUCH"

In 1870, when General Grant was president, the population of our country was 38,000,000. Now it is about 300% as great. What is the population now?

Since *per cent* means *hundredths*, $300\% = \frac{300}{100}$, or 3. Hence 300% of 38,000,000 means $3 \times 38{,}000{,}000$, or 114,000,000.

Our present population is about 114,000,000.

$$\begin{array}{r} 38{,}000{,}000 \\ 3 \\ \hline 114{,}000{,}000 \end{array}$$

300% of a number = 3 times that number

$200\% = \frac{200}{100} = 2 = 2.00$ $\quad$ $1000\% = \frac{1000}{100} = 10 = 10.00$

Exercises

1. Edward had \$45 in the bank a year ago. Now he has 200% of that amount. How much has he now?

Say the following in percentage language:

2. Edith weighs 5 times as much as baby Jane.

3. The schools of Meriden now have 4 times as many pupils as they had 15 yr. ago.

4. Louis has \$5. Mary has twice as much, Will has 3 times as much, and Alice has 5 times as much.

Write the first number as a per cent. Write "of" for ×:

5. $2\times\$50$	**8.** $6\times\$90$	**11.** $3.00\times\$450$
6. $8\times\$35$	**9.** $9\times\$80$	**12.** $4.00\times\$175$
7. $7\times\$40$	**10.** $1\times\$75$	**13.** $10.00\times\$90$

Find the following:

14. 200% of \$8	**17.** 400% of \$15	**20.** 900% of \$800
15. 300% of \$5	**18.** 100% of \$25	**21.** 700% of \$125
16. 600% of \$7	**19.** 200% of \$16	**22.** 1000% of \$250

CAN YOU EXPLAIN THESE STATEMENTS?

Read these very carefully to make sure that you know what each statement means.

1. A house that cost \$5000 is sold for 200% *of what it cost.* At what price is it sold?

2. A house that cost \$5000 is sold for 200% *more than it cost.* At what price is it sold?

3. A house that cost \$5000 is sold for 100% *more than it cost.* At what price is it sold?

4. A house that cost \$5000 is sold *at a profit of* 100%. At what price is it sold?

5. Which of the above problems are merely different ways of saying the same thing?

6. Is it better to sell a dog for 100% of what it cost or for 100% more than it cost? If the dog cost \$15, for how much do you sell it in each case?

Say each in three other ways, in percentage language:

7. Charles bought some stamps for \$4 and sold them for twice as much.

8. Ted bought a bicycle for \$3 and sold it for \$9.

Tell what number should be put in place of the dots:

9. A price 100% above the cost is . .% of the cost.

10. A price 200% above the cost is . .% of the cost.

11. A price 500% above the cost is . .% of the cost.

12. A price . .% above the cost is 200% of the cost.

13. A price . .% above the cost is 400% of the cost.

14. A price . .% above the cost is 100% of the cost.

15. A price . .% above the cost is 300% of the cost.

OTHER PER CENTS LARGER THAN 1

Last April Ben had \$48. Now he has 135% more than that. How much more has he now?

\$48.00
1.35
2 40 00
14 40 0
48 00
\$64.80 00

135% = $\frac{135}{100}$ = 1.35. Hence 135% of \$48.00 is the same as 1.35×\$48.00, or \$64.80.

You see that Ben has \$64.80 *more* now than he had last April.

135% = $\frac{135}{100}$ = 1.35 235% = $\frac{235}{100}$ = 2.35
154% = $\frac{154}{100}$ = 1.54 125% = $\frac{125}{100}$ = 1.25 = $1\frac{1}{4}$

Exercises

1. Show that 150% = 1.50 = $1\frac{1}{2}$; also that 275% = $2\frac{3}{4}$.

Change the following to decimals:

2. 137% **4.** 162% **6.** 251% **8.** 920% **10.** 360%
3. 145% **5.** 103% **7.** 115% **9.** 375% **11.** 502%

12. *Change to per cents:* 1.26 1.01 5.20 $2\frac{1}{4}$ $1\frac{1}{3}$

Find the following:

13. 117% of \$20 **15.** 250% of \$28 **17.** 138% of \$140
14. 125% of \$16 **16.** 222% of \$15 **18.** 103% of \$127

Tell what number should be put in place of the dots:

19. A price 25% above the cost is . .% of the cost.
20. A price 10% above the cost is . .% of the cost.
21. A price 80% above the cost is . .% of the cost.
22. A price $12\frac{1}{2}$% above the cost is . .% of the cost.
23. A price . .% above the cost is 175% of the cost.
24. A price . .% above the cost is 125% of the cost.
25. A price . .% above the cost is 235% of the cost.

FINDING WHAT PART ONE NUMBER IS OF ANOTHER

Review the following in order to get ready for the new work in percentage on page 291.

1. What part of a foot is 1 in.? 5 in.? 6 in.?

2. What part of a yard is 1 in.? 18 in.? 30 in.?

3. What part of an hour is 30 min.? 40 min.? 48 min.?

4. Bert bought a 12-ounce can of cocoa. What part of a pound was this? What part of a pound is 7 oz.?

5. What part of a dollar is a dime? 20¢? 50¢?

6. Peter had 35¢ and spent 10¢ for candy. What part of his money did he spend?

7. Review this rule, which you learned on page 123:

To find what part one number is of a larger one, write the smaller number over the larger one to make a fraction. Then reduce the fraction to lowest terms.

Exercises

1. What part of a minute is 1 sec.? 5 sec.? 10 sec.? 12 sec.? 15 sec.? 20 sec.? 30 sec.? 45 sec.?

2. Of the 40 girls in our school, 24 girls take cooking. What part of the girls is that?

3. Guy lives 30 blocks from school. He rides 25 blocks in a bus and walks the rest of the way. What part of the way does he ride? What part does he walk?

4. Fred is in school 6 hr. of the 24 hr. of the day. What part of the day is he in school?

5. John, Harry, and Will picked 63 qt. of cherries. What part of the 63 qt. did each boy pick if John picked 14 qt., Harry picked 21 qt., and Will picked 28 qt.?

CHANGING COMMON FRACTIONS TO DECIMALS

For the new work on page 291 you must now review the work you had on page 241.

1. Change $\frac{7}{20}$ to a decimal.

$\frac{7}{20}$ means $7 \div 20$. Write 7 as 7.00 and divide as shown at the right. The result is .35.

Hence $\frac{7}{20} = .35$.

$$\begin{array}{r} .35 \\ 20\overline{)7.00} \\ 60 \\ \hline 100 \\ 100 \\ \hline \end{array}$$

To change a common fraction to a decimal, put a decimal point after the numerator, annex 0's, and divide by the denominator.

Change each fraction to a decimal:

2. $\frac{6}{25}$ $\frac{7}{50}$ $\frac{13}{20}$ $\frac{14}{25}$ $\frac{3}{5}$ $\frac{5}{8}$ $\frac{3}{4}$ $\frac{2}{25}$ $\frac{19}{50}$

CHANGING COMMON FRACTIONS TO PER CENTS

1. Change $\frac{7}{20}$ to a per cent.

At the top of this page you changed $\frac{7}{20}$ to .35, which is a two-place decimal meaning hundredths. Since *per cent* also means *hundredths*, you can change .35 to 35%. Hence $\frac{7}{20} = 35\%$.

2. Change $\frac{7}{8}$ to a per cent.

Carry the quotient to only two decimal places, since per cent means hundredths. If there is a remainder, write it as a fraction.

Thus, $\frac{7}{8} = .87\frac{1}{2} = 87\frac{1}{2}\%$.

$$\begin{array}{r} 8\overline{)7.00} \\ \hline .87\frac{1}{2} = 87\frac{1}{2}\% \end{array}$$

To change a common fraction to a per cent, change it to a two-place decimal; then change the decimal to a per cent.

Change each fraction to a per cent:

3. $\frac{31}{50}$ $\frac{17}{20}$ $\frac{2}{25}$ $\frac{3}{4}$ $\frac{3}{16}$ $\frac{1}{50}$

4. $\frac{18}{25}$ $\frac{9}{20}$ $\frac{49}{50}$ $\frac{2}{5}$ $\frac{3}{20}$ $\frac{23}{25}$

5. $\frac{3}{8}$ $\frac{5}{16}$ $\frac{5}{8}$ $\frac{4}{5}$ $\frac{9}{40}$ $\frac{11}{200}$

FINDING WHAT PER CENT ONE NUMBER IS OF ANOTHER

1. What per cent is \$5 of \$10?

2. What per cent of a dozen eggs is 3 eggs? 8 eggs?

3. A quarter is what per cent of a dollar?

4. Our baseball team won 37 games out of 50 games. What per cent of the games played did they win?

First think "37 is what part of 50?" You have already learned that 37 is $\frac{37}{50}$ of 50. Next change $\frac{37}{50}$ to a two-place decimal, which gives .74; then change .74 to 74%.

Hence 37 is 74% of 50, and the team won 74% of its 50 games.

$$\begin{array}{r} .74 = 74\% \\ 50\overline{)37.00} \\ 35\,0 \\ \hline 2\,00 \\ 2\,00 \\ \hline \end{array}$$

To find what per cent one number is of a larger number, find what fractional part the smaller number is of the larger; then change this fraction to a per cent.

Exercises

1. Gladys saves 15¢ of her weekly allowance of 75¢. What per cent of her allowance does she save?

2. In a test of 50 words Jane got 42 words right. Give her mark on this test as a per cent.

3. The Giants won 20 games out of 32 baseball games. What per cent of the games did they win?

Tell what numbers should be put in place of the dots:

4. 26 is . . .% of 50

5. 15 is . . .% of 60

6. 18 is . . .% of 24

7. 7 is . . .% of 25

8. 19 is . . .% of 20

9. 45 is . . .% of 90

10. 17 is . . .% of 50

11. 18 is . . .% of 27

USING PER CENTS TO COMPARE NUMBERS

1. Mary missed 5 questions in a test of 25 questions. What per cent of the test had she wrong? What per cent had she right?

2. The 48 children in Sarah's class elected a class president. 40 children voted for Sarah and the rest voted for John. What per cent of the votes did Sarah get? What per cent did John get?

3. Ruth got a 5-dollar gold piece as a birthday present. She bought a book for \$1.75 and saved the rest of the \$5. What per cent of the money did she save?

When you find what per cent one number is of another, you are really comparing the two numbers.

4. Last winter the price of eggs increased from 48¢ a dozen to 72¢ a dozen. What per cent did it increase?

The price increased 24¢ a dozen. To find the per cent of increase, find what per cent 24¢ is of 48¢.

5. Donald's brother earned \$18.00 a week in a factory. Last week his salary was increased to \$20.70. Find the per cent of increase in his salary.

6. Last June Ralph had \$25 in the bank. Now he has \$45. What per cent have his savings increased?

Compare these numbers by finding what per cent the first number in each problem is of the second:

7. 57 and 75	**12.** 74 and 200	**17.** 42 and 70
8. 36 and 80	**13.** 33 and 150	**18.** 33 and 60
9. 13 and 78	**14.** 69 and 150	**19.** 85 and 250
10. 15 and 24	**15.** 110 and 125	**20.** 68 and 102
11. 50 and 80	**16.** 194 and 200	**21.** 104 and 160

SELLING MAGAZINES

1. When Lewis Brooks read this advertisement, he wrote the following letter:

Radio Monthly
Chicago, Ill.
Dear Sirs:

I should like to get subscriptions for the Radio Monthly. Your advertisement says that you pay 30% commission. Does this mean that I may keep 30% of each $2.00 that I collect for subscriptions?

Yours truly,
Lewis Brooks

AGENTS WANTED

to get subscriptions for the

RADIO MONTHLY

Price $2.00 a year

30% Commission to Agents

2. What reply do you think the Radio Monthly sent Lewis in answer to his question?

3. The first week Lewis got 8 subscriptions and collected $16. He kept 30% of this amount. How much did he keep?

Lewis kept 30% of $16, or $4.80. This $4.80 is called his **commission.** The remaining $11.20, which he sent to the company, is called the **net proceeds.**

$16	$16.00
.30	4.80
$4.80	$11.20

4. Lewis got 17 subscriptions at $1.50 each for another magazine whose agents get 20% commission. Find his commission and the net proceeds.

5. In the summer Polly sells books on a commission of 35%. What is her commission on sales amounting to $50? on sales of $210? on sales of $340?

SELLING ON COMMISSION

1. An auctioneer agrees to sell a piano for Mrs. Harris at a commission of 4%. This means that his pay will be 4% of the price he gets for the piano. What is his commission if he sells the piano for $350? How much will Mrs. Harris receive?

2. Mr. Blake sold his house for $8000 through an agent who charged 2% commission. How much did the agent receive? Find Mr. Blake's net proceeds.

3. Dick sells Mr. Miller's fruit and vegetables during the summer and gets 10% commission. One week he sold $145.60 worth. Find his commission that week.

4. Lillian works in a dress store. She gets $15 a week salary and besides that she receives a commission of 2% on all her sales. If her sales are $585 in one week, find her total earnings that week.

5. Jack sells a radio set for $75 and gets $15 commission. What per cent of $75 is his commission?

Find the commission and the net proceeds on each sale. The first number is the amount of the sales, while the second number is the rate of commission:

6. $950, 40%	**13.** $178, $16\frac{2}{3}\%$	**20.** $650, $16\frac{2}{3}\%$
7. $365, 35%	**14.** $250, $33\frac{1}{3}\%$	**21.** $480, $12\frac{1}{2}\%$
8. $380, 10%	**15.** $475, 20%	**22.** $725, 28%
9. $177, 20%	**16.** $350, 15%	**23.** $1195, 3%
10. $485, 15%	**17.** $160, $12\frac{1}{2}\%$	**24.** $3650, 4%
11. $375, 30%	**18.** $340, 10%	**25.** $4980, 5%
12. $640, 25%	**19.** $243, 45%	**26.** $4230, 2%

HOW BUSINESS MEN FIND THEIR PROFITS

Mr. Brown buys hats at \$1.00 each and sells them at \$1.75 each. But the difference of \$.75 on each hat is not all *profit*, because Mr. Brown has expenses like rent, salaries, light, and heat, which amount to about \$.50 on each hat. These expenses are called **overhead expenses,** or **overhead.**

To find his profit on each hat, Mr. Brown adds the cost and the expenses, which gives \$1.50; then he subtracts this \$1.50 from the selling price, \$1.75, which gives \$.25 as the profit on each hat.

Cost + Expenses + Profit = Selling Price

Exercises

1. Stephen bought a pony for \$45 and sold it an hour later for \$60. He had no overhead expenses. How much was Stephen's profit on the pony?

2. Ralph paid \$45 for a pony and sold it after a month for \$60. During the month he paid \$5 for feed for the pony and \$2 for stable rent. How much were his expenses? How much was Ralph's profit?

3. Mr. Lane bought \$640 worth of electric fans. His overhead expenses were \$280 and he sold the fans for \$860. Find his profit or loss.

Find the amount of profit on each of the following:

	Cost	*Expenses*	*Selling Price*
4. Bicycle . . .	\$18.00	\$5.60	\$30.00
5. Radio set . .	22.50	6.25	35.00
6. Dog	6.00	5.50	14.00
7. Overcoat . .	18.00	6.75	30.00

FINDING THE PER CENT OF PROFIT

Mr. Hale sells for \$32 bicycles for which he pays \$20. His overhead expenses on each bicycle are \$8. What per cent of profit does he make?

The profit on each bicycle is \$4. If Mr. Hale computes his per cent of profit *on the cost*, his profit is 20% of the cost because \$4 is 20% of \$20. But if he figures his profit *on the selling price*, then his profit is $12\frac{1}{2}\%$ of the selling price because \$4 is $12\frac{1}{2}\%$ of \$32.

Formerly it was the general practice in business to compute the per cent of profit on the cost of the goods. To-day, however, it is becoming more and more common to compute the per cent of profit on the selling price.

Always state whether the per cent of profit is computed on the cost or on the selling price.

Exercises

1. Dan buys a horse for \$240. He sells it at \$36 profit. What per cent of the cost is this profit?

2. George sells a radio set that cost him \$32 at a profit of 15% of the cost. How much is his profit?

3. If there are no expenses, find the per cent of profit on the cost and also on the selling price if:

(*a*) I buy a dog at \$20 and sell it at \$25.
(*b*) I buy a dog at \$24 and sell it at \$36.
(*c*) I buy a dog at \$15 and sell it at \$25.

4. At a picnic Will sold ice cream for \$51. The ice cream cost \$34. He paid \$3 rent for the dishes and \$5.50 for other expenses. What was his profit? The profit was what per cent of the cost? of the selling price?

THE PROFITS OF A NEWS STAND

1. Last month Harry paid \$125 for newspapers which he sold for \$200. He paid \$10 rent for the stand and \$15 to George, who helped him. What was Harry's profit? What per cent of his sales was his profit?

2. Last month Tom Flynn paid \$100 for newspapers. His overhead expenses were \$28 and his sales amounted to \$160. What per cent of his sales was his profit?

3. Who had the greater per cent of profit, Harry or Tom? Which was the better business man?

How Much of the Selling Price Is Profit?

1. Mr. Lewis has found that his expenses are 27% of the selling price and that his profits are 8% of the selling price. Tell how much of each of the following sales is profit and how much goes toward expenses.

(*a*) He sells a table for \$40.

(*b*) He sells some chairs for \$150.

(*c*) He sells a writing desk for \$70.

(*d*) His total yearly sales are \$75,000.

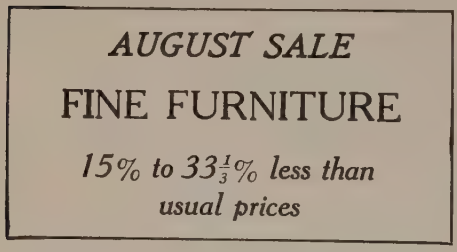
2. Mr. Boyd's expenses are 32% of his total sales, and his profits are 12% of his sales. If his sales for May are \$3500, how much of the \$3500 pays for expenses? How much of it is profit?

How much of these monthly sales covers expenses? How much is profit? Compute the per cents on the sales:

	Sales	*Expenses*	*Profit*		*Sales*	*Expenses*	*Profit*
3.	\$2200	30%	10%	**6.**	\$8560	33%	$12\frac{1}{2}$%
4.	\$4550	26%	12%	**7.**	\$6690	36%	13%
5.	\$3270	25%	15%	**8.**	\$9570	32%	8%

BUYING AT A SALE

When you buy anything at less than the usual price, you are receiving a **discount.** If you buy a table marked \$30 during a sale at $33\frac{1}{3}\%$ less than its marked price, the discount is $33\frac{1}{3}\%$ of \$30, or \$10. Hence you get the table for \$30 − \$10, or \$20.



Exercises

Find all answers correct to the nearest cent.

1. Mrs. Thomas buys furniture for Jack's room. Here are the regular prices, on which she receives a discount of 25%. How much does she pay for each article?

Enameled bed	\$15.60	Chiffonier	\$18.00
Writing desk	22.85	Radio table	4.75
Bookcase	14.00	Stool	1.69

2. Mrs. Thomas also buys these things for Anna's room and gets a discount of 15% from the regular prices. Find the sale price of each article.

Wooden bed	\$22.50	Bureau	\$18.40
Rocking chair	5.00	Lamp	8.00
Sewing table	3.25	Pillow	2.30

3. Mrs. Thomas buys these articles at $33\frac{1}{3}\%$ less than the regular prices. How much does she pay for each?

China closet	\$35.00	Chair	\$12.60
Dining-room table	36.75	Couch	29.40

4. Work ex. 3 again using 40% as the rate of discount.

BUYING GOODS AT A DISCOUNT

1. If footballs are selling at $33\frac{1}{3}\%$ off, how much does a football marked \$10.85 cost?

2. If fur coats are sold at 35% less than the marked price, find the cost of a coat marked \$175.

3. Mr. Davis will sell Frank a bicycle for \$28.75 on the installment plan. If Frank pays cash, he gets 8% discount. How much does he save by paying cash?

4. A flashlight, formerly marked \$3.80, now costs \$3.23. What per cent discount on \$3.80 does this equal?

The discount is 57¢. What per cent of \$3.80 is 57¢?

5. Girls' coats are advertised thus: "Regular price, \$17.00; sale price, \$12.75." Find the per cent of discount on the regular price. Find the per cent of discount on a coat selling at \$15.00 if the regular price was \$22.50.

6. The Ajax Store is selling tennis rackets marked \$5.00 at $33\frac{1}{3}\%$ less than the marked price. The Sports Store is selling similar rackets at \$3.50. Which is the better bargain?

7. If Mrs. Loft pays her electric light bill before the fifth of the month, she gets 5% discount. How much does she save on a bill for \$3.87 by paying promptly?

Find, to the nearest cent, the discount on each amount. The amounts given are the regular prices:

8. \$4.50, $16\frac{2}{3}\%$
9. \$8.50, 40%
10. \$7.74, $33\frac{1}{3}\%$
11. \$3.75, 50%
12. \$6.45, 25%
13. \$9.60, 15%
14. \$10.98, 30%
15. \$15.46, 20%
16. \$3.95, $12\frac{1}{2}\%$
17. \$8.67, $33\frac{1}{3}\%$
18. \$5.98, $37\frac{1}{2}\%$
19. \$6.72, 35%

TRADE DISCOUNT

George Fox runs a shoe store. He is a *retail merchant* because he sells things to the people in his neighborhood. He buys the shoes in large quantities from a *wholesale merchant* at *wholesale prices.*

The *wholesale merchant* sends Mr. Fox a catalogue giving the *list prices* of his goods. The list price of each article in the catalogue is usually higher than the actual wholesale price, because it would be too expensive for the wholesale house to publish a new catalogue every time a price changes, while it is easy to lower a price at any time by allowing a discount on the list price.

A discount may also be allowed to a retail merchant for a very large order or for prompt payment.

The discount allowed to a retail merchant is always stated on his bill, as shown below. Such a discount is called a **trade discount.** The actual price that the retail merchant pays the wholesale merchant after the discount is deducted is called the **net price.**

Here is a bill which a wholesale merchant sent to Mr. Fox:

MASON SHOE COMPANY
Wholesale Shoe Merchants

Sold to George Fox, Yonkers, N.Y. Boston, Mass. Feb. 18, 19—

Terms: 30 days Shipped by express

36	Pairs Boys' Low Shoes Style 27 @3.20	115	20		
48	Pairs Ladies' Pumps Style 18 @3.75	180	00		
		295	20		
	Discount, 20%	59	04		
				236	16

FINDING THE STOREKEEPER'S DISCOUNT

1. In the bill at the bottom of page 300, which are the list prices? How much discount is allowed? What is the total net price?

2. If you want a pound of sugar or an overcoat, do you go to a retail store or to a wholesale store?

3. A hotel manager needs 50 doz. cans of tomatoes. Does he go to a wholesale store or to a retail store? Why?

4. Give the names of as many retail stores in your neighborhood as you can.

5. Name some wholesale merchants or some manufacturers who sell at wholesale prices.

6. Nina's father consults a catalogue and orders the following shoes: 72 pairs girls' pumps, style 167, @ \$2.95; 144 pairs men's rubbers @ \$.85. If he receives a discount of $33\frac{1}{3}\%$, find the total net price. Make out the bill, showing the discount on it.

7. Mr. Drew orders 6 stoves at \$34.95 each. Find the total net price if he receives 20% discount.

Find the discount and the net price on these list prices:

8. \$250, $12\frac{1}{2}\%$	**17.** \$995, 20%	**26.** \$1396, 18%
9. \$340, 25%	**18.** \$856, 10%	**27.** \$2590, $33\frac{1}{3}\%$
10. \$430, 40%	**19.** \$741, $33\frac{1}{3}\%$	**28.** \$1865, $16\frac{2}{3}\%$
11. \$765, $33\frac{1}{3}\%$	**20.** \$950, 40%	**29.** \$9850, 30%
12. \$954, 20%	**21.** \$865, 35%	**30.** \$1459, 35%
13. \$758, $16\frac{2}{3}\%$	**22.** \$982, 30%	**31.** \$2050, 50%
14. \$660, 30%	**23.** \$429, 25%	**32.** \$1897, 45%
15. \$482, 15%	**24.** \$653, $16\frac{2}{3}\%$	**33.** \$3205, $66\frac{2}{3}\%$
16. \$675, 25%	**25.** \$255, 40%	**34.** \$4500, 50%

INTEREST

Mr. Thompson rents a house at the seashore. He pays the owner \$75 a month rent for the use of the house.

Mr. Fields borrows \$500 from Mr. Clark. He must pay Mr. Clark 6% of the \$500, or \$30, for the use of this money for 1 year. The \$500 which he borrows is the **principal**; the \$30 which he pays for the use of it is the **interest.** Interest is paid for the use of money, just as rent is paid for the use of a house.

The \$30 interest is 6% of \$500; 6% is called the **rate of interest.** Unless otherwise agreed, the rate of interest is understood to be the charge for 1 year's use of the money. If Mr. Fields borrows the money for 2 years, he has to pay twice as much interest, or \$60.

When money is put in the savings bank, the bank pays interest on it because the bank has the use of the money and often lends it to other people.

Exercises

Find the interest on each amount for 1 *yr.:*

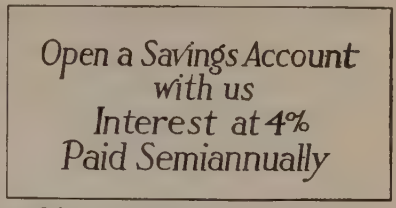
1. \$200 at 6%	**7.** \$35 at 4%	**13.** \$1450 at 6%
2. \$350 at 5%	**8.** \$80 at 5%	**14.** \$2600 at 5%
3. \$800 at 4%	**9.** \$75 at 6%	**15.** \$1000 at 3%
4. \$150 at 7%	**10.** \$90 at 7%	**16.** \$1250 at 4%
5. \$750 at 6%	**11.** \$110 at 3%	**17.** \$16.25 at 8%
6. \$250 at 7%	**12.** \$175 at 6%	**18.** \$27.50 at 7%

19. Fred borrowed \$50 from his brother for 1 yr. at 5% interest. How much interest did he pay?

20. Amy put \$25 in a savings bank which pays 4% interest. How much interest did she get on it in 1 yr.?

PAYING INTEREST SEMIANNUALLY

Roger saw this sign on the window of a savings bank.



A bank that pays interest semiannually pays interest every 6 mo. instead of every year. If Roger has \$25 in this bank, the interest on it for 1 yr. at 4% is \$1; but instead of making Roger wait a year for his interest, the bank pays half of it (50¢) at the end of 6 mo. and the other half at the end of the year.

Exercises

1. Mr. Brett has \$800 in a bank that pays interest at 4% semiannually. How much interest does he receive each half year?

Interest "at 4%" means at 4% *for one year*. For 6 mo. the interest is half as much. The interest on \$800 for a whole year at 4% is \$32, while for 6 mo. it is $\frac{1}{2}$ of \$32, or \$16.

Hence Mr. Brett receives \$16 interest every 6 mo.

$$\begin{array}{r} 800 \\ .04 \\ \hline 2\overline{)32.00} \\ 16.00 \end{array}$$

2. Belle has \$35 in a savings bank that pays 4%. How much interest does she get every 6 mo.?

3. Paul borrowed \$600 and paid interest on it semiannually at 6%. How much did he pay every 6 mo.?

Tell how much interest is paid semiannually on:

4. \$150 at 6%	**8.** \$65 at 4%	**12.** \$42 at 4%
5. \$280 at 6%	**9.** \$30 at 4%	**13.** \$15 at 4%
6. \$700 at 4%	**10.** \$75 at 8%	**14.** \$75 at 6%
7. \$950 at 6%	**11.** \$90 at 7%	**15.** \$50 at 5%

BORROWING MONEY TO GO TO COLLEGE

1. George borrowed \$800 at 6% to enable him to go to college. He kept the money for 4 yr. How much interest did he pay in that time?

The interest for 1 yr. is 6% of \$800, or \$48.
Hence the total interest for 4 yr. is 4×\$48, or \$192.
You see that in 4 yr. George paid \$192 interest.
Arrange the work as shown at the right.

800
.06
48.00
4
192.00

2. Myra borrowed \$700 for $2\frac{1}{2}$ yr. to help her finish her college course. At 5%, how much interest did she have to pay during that time?

3. A student who borrowed \$1250 at 6% kept the money for 3 yr. Find the total interest.

4. When he started to go to college, Glenn borrowed \$600 at 7% interest. He repaid the loan 5 yr. later. Find the total interest he paid during that time.

Find, to the nearest cent, the interest on:

5. \$200 for 2 yr. at 5%
6. \$250 for 5 yr. at 5%
7. \$780 for 3 yr. at 4%
8. \$150 for 3 yr. at 6%
9. \$900 for 4 yr. at 7%
10. \$650 for 2 yr. at 7%
11. \$340 for 5 yr. at 4%
12. \$980 for 4 yr. at 6%
13. \$1500 for 6 yr. at 5%
14. \$3850 for 5 yr. at 3%
15. \$6275 for 4 yr. at 5%
16. \$500 for $2\frac{3}{4}$ yr. at 6%
17. \$600 for $3\frac{1}{2}$ yr. at 5%
18. \$350 for $1\frac{1}{4}$ yr. at 4%
19. \$980 for $4\frac{1}{2}$ yr. at 6%
20. \$740 for $3\frac{3}{4}$ yr. at 3%
21. \$670 for $3\frac{1}{2}$ yr. at 7%
22. \$350 for $1\frac{1}{4}$ yr. at 7%
23. \$495 for $5\frac{1}{2}$ yr. at 6%
24. \$876 for $2\frac{1}{4}$ yr. at 5%
25. \$235 for $3\frac{1}{2}$ yr. at 7%
26. \$913 for $1\frac{3}{4}$ yr. at 6%

HOW MUCH DID MR. FOX MAKE ON HIS LOT?

Mr. Fox bought a lot for \$600. He kept it for 3 yr. and paid \$20 taxes on it each year. Then he sold it for \$700.

Claude said that, deducting the total \$60 spent for taxes, Mr. Fox made only \$40 on the lot.

Eva said that Mr. Fox did not make even \$40. If he had not bought the lot, he could have lent his \$600 to some one and received 5% interest each year, or \$90 in 3 yr. Thus he could have earned \$90 interest. By buying the lot he made only \$40. Hence he really lost \$50 on the lot.

Who was right, Eva or Claude?

Money earns interest if you lend it to a reliable person or put it in a savings bank. If you buy something with it, as Mr. Fox did, hoping to sell it at a profit, you lose money unless the actual profit is more than the interest that the money could earn.

Exercises

1. Mr. Watt bought a lot for \$1000 and sold it 2 yr. later for \$1300. He paid \$35 a year taxes and gave Mr. Lodge \$78 for selling it. Find Mr. Watt's profit. Would he have made more or less by lending the \$1000 for 2 yr. at 6%? how much more or less?

2. Ada kept \$50 in a toy bank for 1 yr. How much did she lose by not lending it at 4% interest?

FINDING INTEREST FOR PARTS OF A YEAR

1. What part of a year is 1 mo.? 5 mo.? 7 mo.? 4 mo.? 6 mo.? 3 mo.? 9 mo.? 8 mo.?

2. If I borrow \$400 for 1 yr. from Mr. Mead, he charges me \$24 interest. How much should he charge me for 6 mo.? for 1 mo.? 5 mo.? 3 mo.? 8 mo.? 9 mo.?

3. Mr. Long lends John \$150 at 5%. If John keeps the money for 7 mo., how much interest does he pay?

The interest for 1 yr. is 5% of \$150, or \$7.50. Since 7 mo. is $\frac{7}{12}$ of 1 yr., the interest for 7 mo. is $\frac{7}{12}\times\$7.50$, or \$4.38, to the nearest cent. The product \$4.38 is found by multiplying \$7.50 by 7 and dividing the result by 12, as shown at the right.

$$\begin{array}{r} 7.50 \\ \times\ 7 \\ \hline 12\overline{)52.50} \\ 4.37\frac{1}{2} \end{array}$$

4. Mr. Parker borrows \$1500, which he pays back at the end of 8 mo. with interest at 6%. How much interest does he pay? What is the total amount due at the end of 8 mo.?

Find the interest, to the nearest cent, on:

5. \$200 for 6 mo. at 4%
6. \$350 for 3 mo. at 6%
7. \$700 for 9 mo. at 5%
8. \$550 for 4 mo. at 7%
9. \$840 for 7 mo. at 6%
10. \$920 for 8 mo. at 5%
11. \$175 for 6 mo. at 5%
12. \$300 for 4 mo. at 6%
13. \$500 for 1 mo. at 6%
14. \$890 for 2 mo. at 6%
15. \$450 for 5 mo. at 6%
16. \$950 for 2 mo. at 6%
17. \$700 for 7 mo. at 4%
18. \$1000 for 3 mo. at 5%
19. \$1250 for 8 mo. at 6%
20. \$4500 for 1 mo. at 6%

21. Mr. Roberts borrows \$350, at 6% interest, to repair his house. He keeps the money 2 yr. 9 mo. How much interest does he pay during this time?

IMPROVEMENT TEST No. 20

Test 20 A — Reduction (Time 3 min. after copying)

Change to decimals:

1. 36% **2.** 2% **3.** 100% **4.** 200% **5.** 135%

Change to common fractions in lowest terms:

6. 25% **7.** 5% **8.** 10% **9.** 40% **10.** $87\frac{1}{2}\%$

11. 75% **12.** 4% **13.** 15% **14.** 64% **15.** $66\frac{2}{3}\%$

Change to per cents:

16. $\frac{1}{2}$ **17.** $\frac{1}{6}$ **18.** 1 **19.** .59 **20.** 1.18

21. $\frac{5}{6}$ **22.** $\frac{5}{8}$ **23.** 4 **24.** .03 **25.** 5.00

Test 20 B — Finding Per Cents (Time 4 min. after copying)

1. 9% of 200 **2.** 64% of 625 **3.** $33\frac{1}{3}\%$ of 579

4. 2% of 825 **5.** 14% of 750 **6.** 104% of 325

7. 6% of 850 **8.** 65% of 980 **9.** 275% of 664

Test 20 C — Finding Per Cents (Time 4 min. after copying)

Find results correct to the nearest cent:

1. 1% of \$453.26 **2.** 36% of \$395.05

3. 7% of \$431.80 **4.** $33\frac{1}{3}\%$ of \$817.60

5. 8% of \$255.75 **6.** 125% of \$500.91

NOTE. The Scoring Table does not provide for 25 examples; hence in scoring Test 20 A, the pupil should first find what per cent of the examples he has right and then find his score from this per cent. If he has 84% right, his score is 8; if he has 88% right, his score is 9.

COST OF OPERATING A CAR

1. Mr. Smith paid \$1270 for an automobile. After using the car for 2 yr., he sold it for \$725. How much did it lose in value? Such a loss is called *depreciation* and is one of the expenses of owning a car.

2. If Mr. Smith had not bought the car, he could have received 6% interest on the \$1270 he paid for it. How much would the interest be for 2 yr.? This loss of interest is another one of the expenses of owning a car.

3. During the 2 yr. Mr. Smith used a total of 1367 gal. of gasoline, which cost an average of 18¢ a gallon. He also used 51 gal. of oil at 64¢ a gallon. How much did the fuel and oil together cost?

4. During the 2 yr. he also paid \$140 for tires, \$62.65 for taxes, \$64.74 for repairs, washing, etc., and he was in an automobile accident that cost him \$75.99. Find the total amount of these items.

5. He paid \$8 a month garage rent, \$7 each year for a car license, and \$3 each year for a driver's license. How much did these items amount to in 2 yr.?

6. Find the total cost of the car for the 2 yr. that Mr. Smith had it. (Add together the answers of ex. 1 to 5.)

7. Mr. Smith drove the car a total of 20,151 mi. during the 2 yr. he had it. Using the total cost found in ex. 6, find, to the nearest tenth of a cent, how much it cost him per mile to run his car.

8. Since Mr. Smith used 1367 gal. of gasoline to travel 20,151 mi. (see ex. 3 and 7), how many miles did he average per gallon of gasoline? Find the result to the nearest tenth of a mile.

DENOMINATE NUMBERS

Measuring Lengths

On pages 130 to 150 of this book you learned about important units of measure like the foot, the mile, the pound, and the quart. Numbers like 3 ft., $4\frac{1}{2}$ lb., and 7 qt. are called **denominate numbers.**

Review this table of *length:*

12 inches (in.)	= 1 foot (ft.)
3 feet	= 1 yard (yd.)
$16\frac{1}{2}$ feet or $5\frac{1}{2}$ yards	= 1 rod (rd.)
5280 feet or 320 rods	= 1 mile (mi.)

Exercises

1. How many feet are there in 3 yd.? in 2 rd.? in $\frac{1}{4}$ mi.? in 100 in.? in 6 in.?

2. How many yards are there in 6 rd.? in $\frac{1}{2}$ mi.? in 96 ft.?

3. A boy's step measures $2\frac{1}{4}$ ft. In walking $\frac{3}{4}$ mi. how many steps will he take?

4. Mr. Archer finds that the distance around the deck of a steamship is 264 ft. How many times must he go around the deck to walk a mile?

5. Jack said that his uncle's collection of stamps was half a mile long. He meant that the stamps, put end to end, would cover $\frac{1}{2}$ mi. If the average length of a stamp is 1 in., how many stamps had Jack's uncle?

6. On field day, Jack ran the 200-yard dash. How far, to the nearest hundredth of a mile, did he run?

7. The deepest place in the Atlantic Ocean is 31,366 ft. deep. Express this to the nearest hundredth of a mile.

HOW FRUITS AND VEGETABLES ARE MEASURED

Fruits, vegetables, and grain usually are sold either by weight or by dry measure.

Review this table of *dry measure:*

2 pints (pt.) = 1 quart (qt.)
8 quarts = 1 peck (pk.)
4 pecks = 1 bushel (bu.)

Review this table of *weight:*

16 ounces (oz.) = 1 pound (lb.)
100 pounds = 1 hundredweight (cwt.)
2000 pounds = 1 ton (T.)

Exercises

1. How many quarts are there in $1\frac{1}{2}$ pk.? in $\frac{1}{2}$ bu.? in 7 pt.? in $1\frac{1}{4}$ bu.? in $\frac{1}{4}$ pk.? in 1 pt.?

2. How many pounds are there in 8 oz.? in $\frac{1}{4}$ T.? in $1\frac{1}{2}$ cwt.? in 24 oz.? in 5 T.? in 10 cwt.?

3. John sold string beans from his garden at 10¢ a quart. How much did he receive for 4 pk.? for 7 qt.?

4. Mr. Ross feeds his horse $1\frac{1}{4}$ pk. of oats a day. How many days will 10 bu. of oats last?

5. Coal was delivered to a factory in truck loads. Each time that a load was delivered, the truck full of coal was weighed on the factory scales; the weight of the truck was then subtracted, which gave the weight of the coal. It was thus found that the number of pounds of coal delivered in the four loads was as follows: 6550, 6810, 6905, and 6135. How many tons of coal were delivered?

MEASURING LIQUIDS

1. Review this table of *liquid measure:*

2 pints (pt.) = 1 quart (qt.)
4 quarts = 1 gallon (gal.)

2. How many quarts are there in $6\frac{1}{2}$ gal.? in 10 pt.? in $\frac{3}{4}$ gal.? in 1 pt.? in $1\frac{1}{2}$ gal.? in 20 gal.?

3. How many gallons are there in 30 qt.? in 18 pt.?

4. Mr. Low gets \$3.20 per 100 lb. for milk. How much will he get for 1250 lb. of milk?

5. How many gallons of ice cream are needed for 88 children if $\frac{1}{2}$ pt. is allowed for each child?

MEASURING TIME

1. Review this table of *time:*

60 seconds (sec.) = 1 minute (min.)
60 minutes = 1 hour (hr.)
24 hours = 1 day (da.)
7 days = 1 week (wk.)
365 days or 12 months (mo.) = 1 year (yr.)
366 days = 1 leap year
100 years = 1 century

2. If your heart beats 80 times a minute, how many times does it beat in a day? how many times in a week? in a year (52 weeks)? Do you see why you should take good care of your heart?

3. Beginning at 6.08 A.M., the trolley passes our house every 12 min. Make a time-table showing every time the trolley passes from 6.08 A.M. until noon.

HOW TO REDUCE COMPOUND NUMBERS

1. Virginia Henderson is 4 ft. 10 in. tall. How many inches tall is Virginia?

Doing the work as at the right, you see that 4 ft. 10 in. = 58 in. Hence Virginia is 58 in. tall.

1 ft. = 12 in.
4 ft. = 48 in.
48 in. + 10 in. = 58 in.

2. James finds that his step is 27 in. long. How many feet and inches does 27 in. make?

There are 12 in. in 1 ft. To find the number of feet there are in 27 in., you must find how many times 12 in. is contained in 27 in. Dividing 27 in. by 12 in., you get 2, with 3 in. left over.

Hence 27 in. equals 2 ft. 3 in.

$$\begin{array}{r} 2 \\ 12\overline{)27} \\ 24 \\ \hline 3 \end{array}$$

Numbers like 2 ft. 3 in., which contain two or more units of measure, are called **compound denominate numbers.**

Exercises

1. Mary bought some cloth 54 in. wide. How many yards and inches wide was it?

2. At school, Irving has 135 min. of shop work each week. How many hours and minutes is this?

3. Sam is 5 ft. 2 in. tall. How many inches tall is he?

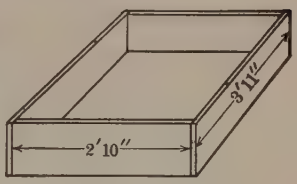
4. Mrs. Jackson bought 62 qt. of milk last month. How many gallons and quarts did she buy?

Tell what numbers should be put in place of the dots:

5. 7 yd. 2 ft. = . . . ft.
6. 4 lb. 2 oz. = . . . oz.
7. 4 gal. 3 qt. = . . . qt.
8. 5 bu. 3 pk. = . . . pk.
9. 2 hr. 7 min. = . . . min.
10. 70 in. = . . ft. . . . in.
11. 40 oz. = . . lb. . . . oz.
12. 19 qt. = . . pk. . . . qt.
13. 45 in. = . . yd. . . . in.
14. 11,220 ft. = . . mi. . . . ft.

HOW TO ADD FEET AND INCHES

To make the sides of this box, John needs two pieces of board each 3 ft. 11 in. long, and two pieces each 2 ft. 10 in. long. If John cuts the four pieces from one board, how long must the board be?



3 ft.	**11 in.**
3 ft.	**11 in.**
2 ft.	**10 in.**
2 ft.	**10 in.**
13 ft.	**6 in.**

To add the lengths of the four pieces, first add the inches, which gives 42 in., or 3 ft. 6 in. Write 6 in. and carry 3 ft. to the next column. Then add the feet, which gives 13 ft.

John needs a board 13 ft. 6 in. long.

Exercises

1. Mrs. Nelson's dining-room table is 5 ft. 6 in. long. If she puts in 2 extra leaves, each 1 ft. 4 in. wide, how long will the table be?

Add. Check the work by going over it again:

2.

ft.	in.
1	2
7	9
3	4
5	8

3.

ft.	in.
2	6
9	3
7	4
8	10

4.

yd.	ft.
1	2
7	2
8	1
9	2

5.

ft.	in.
4	0
3	11
2	8
4	1

6.

ft.	in.
1	2
9	11
6	10
4	8
9	9

7.

ft.	in.
1	7
2	3
4	11
5	0
8	8

8.

yd.	ft.
2	1
4	1
5	0
7	1
8	2

9.

yd.	in.
2	3
1	20
	6
9	18
5	31

ADDING HOURS AND MINUTES

Dick worked 3 hr. 20 min. on Monday, 2 hr. 45 min. on Tuesday, and 1 hr. 45 min. on Friday. Find his total time.

Adding the minutes, you get 110 min., which must be changed to 1 hr. 50 min. Write 50 min. and carry 1 hr. to the *hour* column. Adding the hours, you get 7 hr.

Hence Dick worked 7 hr. 50 min. in all.

3 hr. 20 min.
2 hr. 45 min.
1 hr. 45 min.
7 hr. 50 min.

Exercises

1. These children were paid by the hour for addressing envelopes. Find the total time each child worked.

	John	*Ellen*	*Nancy*
Mon.	1 hr. 20 min.	2 hr. 10 min.	1 hr. 35 min.
Tues.	2 hr. 5 min.	1 hr. 45 min.	45 min.
Wed.	55 min.	1 hr. 50 min.	2 hr. 15 min.
Thurs.	1 hr. 50 min.	2 hr. 30 min.	3 hr. 5 min.

2. Alfred helped last Saturday at the Sweets Shop. He sold 2 gal. 1 qt. of vanilla ice cream, 3 gal. 2 qt. of chocolate ice cream, and 4 gal. 3 qt. of peach ice cream. How much ice cream did he sell in all?

3. Robert orders articles of the following weights from a mail-order store: suit, 3 lb. 8 oz.; socks, 8 oz.; hat, 14 oz.; shoes, 1 lb. 6 oz.; gloves, 4 oz.; skates, 3 lb. 10 oz.; boots, 3 lb. 12 oz. Find the total weight of these articles.

Add. Check the work by going over it again:

	hr.	min.		hr.	min.		bu.	pk.		lb.	oz.
4.	1	10	**5.**	7	10	**6.**	2	1	**7.**	9	15
	3	45		5	35		1	3			4
	2	30		4	20		5	2		8	3
	2	18		3	25		3	1		2	10

SUBTRACTING FEET AND INCHES

John throws a basket ball 36 ft. 9 in. Walter throws it 41 ft. 5 in. By how much does Walter beat John?

Since you cannot take 9 in. from 5 in., think of 41 ft. 5 in. as 40 ft. 17 in. Then 17 in. − 9 in. = 8 in. and 40 ft. − 36 ft. = 4 ft.
Hence Walter beats John by 4 ft. 8 in.

41 ft. 5 in.
36 ft. 9 in.
4 ft. 8 in.

Exercises

1. Michael Donnelly jumps 5 ft. 5 in. in the standing broad jump. Tell by how much Michael beats each of the following boys:

Clyde,	5 ft. 2½ in.	Will,	5 ft. 0 in.
Henry,	4 ft. 10 in.	Hugh,	4 ft. 9 in.
Elmer,	4 ft. 7 in.	Dick,	4 ft. 6 in.

2. Mr. Hall is 6 ft. 2 in. tall and Ray is 4 ft. 10 in. tall. Find the difference in their heights.

3. A package sent by parcel post must not weigh more than 70 lb. What is the greatest number of pounds of books that you can ship in a box weighing 6 lb. 5 oz.? in a box weighing 8 lb. 3 oz.?

4. Arthur started on a hiking trip at 1.45 P.M. and got back at 5.10 P.M. How long was he gone?

5.10 P.M. means 5 hr. 10 min. after noon. What does 1.45 P.M. mean? Since you cannot subtract 45 from 10, think of 5 hr. 10 min. as 4 hr. 70 min. and then subtract as shown at the right.

5 hr. 10 min.
1 hr. 45 min.
3 hr. 25 min.

Subtract. Check the work by going over it again:

	ft.	in.		yd.	ft.		lb.	oz.		hr.	min.
5.	8	2	**6.**	7	1	**7.**	6	10	**8.**	7	15
	4	7		5	2		3	15		5	30

HOW FAR CAN YOU JUMP?

Healthy boys and girls should be able to make these records in running, jumping, and throwing.

Age	Standing Broad Jump		Running Broad Jump		50-Yard Dash		Ball Throw Free Style	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
11	4′ 10″	4′ 2″	8′ 3″	6′ 6″	$8\frac{3}{5}$ sec.	$9\frac{1}{5}$ sec.	38′	30′
12	5′ 0″	4′ 4″	9′ 3″	7′ 0″	$8\frac{1}{5}$ sec.	9 sec.	46′	32′
13	5′ 2″	4′ 6″	10′ 0″	7′ 2″	8 sec.	$8\frac{4}{5}$ sec.	54′	32′
14	5′ 6″	4′ 8″	10′ 6″	7′ 6″	$7\frac{4}{5}$ sec.	$8\frac{3}{5}$ sec.	60′	38′

You see that a boy of 11 should be able to jump 4 ft. 10 in. in the standing broad jump, to run 50 yd. in $8\frac{3}{5}$ sec., and to throw a ball 38 ft. These numbers are called the " age standards " for each event.

1. From the above table, tell how far a girl of 12 should jump in the standing broad jump; in the running broad jump. Tell how long it would take her to run 50 yd.

2. How much further should a boy of 11 jump in the standing broad jump than a girl of 11? Answer the same question for boys and girls of 12; of 13; of 14.

COMPARING ATHLETIC RECORDS

In working these problems, use the table on page 316.

1. How much farther should a boy of each age jump in a running broad jump than a girl of the same age?

2. In the 50-yard dash a boy of each age should run how much faster than a girl of the same age?

3. Compare each of these records in the running broad jump with the standards in the table:

Gene, age 11, 9′ 1″	Alice, age 12, 8′ 4″
Will, age 14, 8′ 8″	Fanny, age 13, 6′ 9″
Bert, age 13, 8′ 9″	Julia, age 11, 7′ 2″

4. How much farther did Gene jump than each of the other children in ex. 3?

5. Irving, who is 11, ran 50 yd. in $8\frac{1}{10}$ sec. How much less time was that than the standard for his age?

6. Elinor, who is 13, did 5 ft. 1 in. in a standing broad jump. How much is that above the girls' standard? How close is it to the boys' standard?

7. Find how far you can jump and throw a ball and how long it takes you to run 50 yd. Then compare your records with the standards for your age.

8. Barbara is 13 yr. old. She can throw a ball 40 ft. 3 in. By how much does she beat her standard?

9. In ex. 8, how much farther would Barbara have to throw the ball to reach the boys' standard for 13 yr.?

10. Edwin is 13 and does the 50-yard dash in $7\frac{3}{5}$ sec. How much better than the standard is this?

11. Kenneth is 12 yr. old. He threw a ball 42 ft. 8 in. How close did he come to the 12-year-old record?

PREPARING FOR CAMP

1. Edna is taking 4 blankets to camp. Each weighs 3 lb. 5 oz. What is the total weight of the blankets?

First multiply 5 oz. by 4, which gives 20 oz., or 1 lb. 4 oz. Write 4 oz. and carry 1 lb. Then multiply 3 lb. by 4 and add 1 lb. (carried), which gives 13 lb. The 4 blankets weigh 13 lb. 4 oz.

3 lb. 5 oz.
4
13 lb. 4 oz.

2. Edna is also taking to camp 3 pairs of tweed knickers weighing 1 lb. 2 oz. each. How much do the knickers weigh in all?

3. Find the total weight, in pounds and ounces, of 6 middy blouses weighing 9 oz. each.

4. Edna is taking 2 serge skirts weighing 1 lb. 2 oz. each and 2 sweaters weighing 1 lb. 9 oz. each. How much do all of these weigh?

5. How heavy will 5 books on nature study be if each book weighs 1 lb. 4 oz.?

Practice in Multiplying Compound Numbers

1. Elizabeth found this problem in her grandfather's arithmetic: Multiply 2 mi. 17 rd. 4 yd. 2 ft. 7 in. by 6. Can you do it, even though it isn't a practical problem?

Multiply. Check the work by going over it:

2. 4 ft. 3 in. × 7

3. 6 gal. 2 qt. × 5

4. 8 hr. 15 min. × 2

5. 9 yd. 2 ft. × 7

6. 7 lb. 6 oz. × 3

7. 2 ft. 8 in. × 9

8. 7 pk. 4 qt. × 4

9. 2 yd. 8 in. × 5

10. 2 ft. 5 in. × 4

FINDING THE LENGTH OF YOUR STEP

1. The cement walk to the door of Mark's house is 33 ft. 9 in. long. Mark takes 15 steps in walking it. Find the average length of his step.

Dividing 33 ft. by 15, you get 2 ft. and a remainder of 3 ft. Write 2 ft. Then change 3 ft. to 36 in. and add it to 9 in., which gives 45 in. Dividing 45 in. by 15, you get 3 in.

The average length of Mark's step is 2 ft. 3 in.

$$15\overline{)33 \text{ ft. } 9 \text{ in.}}$$
$$2 \text{ ft. } 3 \text{ in.}$$

2. Mark's sister walks only 31 ft. 3 in. in 15 steps. What is the average length of her step?

3. Little Hilda can go across a garden 17 ft. 4 in. wide in 13 steps. How long is her step?

4. Count the number of steps you take to walk 100 ft. What is the average length of your step?

Other Problems

1. In 6 days Jane spent 7 hr. 30 min. practicing on the piano. Find her average time per day.

2. Polly picks 3 baskets of cherries in 5 hr. 45 min. What is her average time per basket?

3. A catalogue says that 1 doz. scout axes weigh 27 lb. 12 oz. Find the weight of each axe.

4. An ocean liner made these records on 5 different trips between New York and England: 6 da. 3 hr., 5 da. 22 hr., 5 da. 20 hr., 6 da. 7 hr., and 5 da. 15 hr. Find the average time for a trip.

5. Sam tried the standing broad jump 6 times. These are his records: 4 ft. 10 in., 4 ft. 8 in., 4 ft. 9 in., 5 ft. 0 in., 4 ft. 8 in.. 5 ft. 1 in. Find the average length of his jump.

FINDING THE PERIMETER OF A RECTANGLE

1. How often must Paul ride around a city block 360 ft. long and 300 ft. wide to go a mile?

The distance around the block is 300 ft. + 360 ft. + 300 ft. + 360 ft., or 1320 ft. Since 5280 ft. make a mile, divide 5280 by 1320 to find how many times Paul must ride around the block to go a mile.

The distance around any rectangle is called its **perimeter.** How do you find the perimeter of a rectangle?

2. How much string will you need to go around a tulip bed which is $3\frac{1}{2}$ ft. wide and $7\frac{1}{4}$ ft. long?

3. A baseball diamond is a square 90 ft. on a side. How many yards does a boy run in making a home run?

4. Janet is bordering with lace a table scarf $1\frac{1}{2}$ ft. by $3\frac{1}{4}$ ft. How many yards of lace does she need if she allows 6 in. extra in all for turning the corners?

5. Here are the sizes of six different gardens:

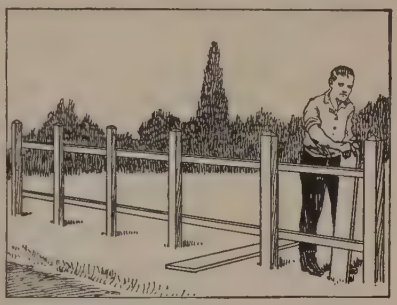
Fred's,	30 ft. × 30 ft.	Mary's,	12 ft. × 75 ft.
Jane's,	18 ft. × 50 ft.	Dick's,	10 ft. × 90 ft.
Will's,	20 ft. × 45 ft.	Dora's,	15 ft. × 60 ft.

How many feet of wire netting will be needed for a fence for each garden? Which garden will need the least netting?

6. Compare the areas of the gardens in ex. 5. Draw each garden to scale, letting $\frac{1}{8}$ in. = 1 ft. What is the shape of the garden that takes the least amount of wire netting?

FENCING AND GARDEN PROBLEMS

1. Mr. Drew is putting a fence 25 ft. long across the front of his lot. He sets the posts 5 ft. apart. Roger says that he needs 5 posts because 25 ft. ÷ 5 ft. = 5. Hilda says that he needs 6 posts because he must allow 1 extra post for the end of the row. Who is right?



2. In her garden Alice is setting tomato plants 2 ft. apart. How many plants will there be in each row if the rows are 16 ft. long? if the rows are 12 ft. long? 20 ft. long? 24 ft. long?

3. Louise is planting tulip bulbs in her garden in rows 6 ft. long. How many bulbs will there be in each row if she sets them 6 in. apart? if she sets them 4 in. apart? 3 in. apart? 8 in. apart?

4. William is putting a wire netting around a garden 30 ft. long and 20 ft. wide. If he fastens the netting to posts which are set 5 ft. apart, how many posts will it take to go all around the garden? Does he have to allow an extra post, as in ex. 1? Prove that your answer is right by making a diagram showing how the posts are set.

In your garden, how many plants can you set:

5. In a row 15 ft. long, with the plants $1\frac{1}{4}$ ft. apart?

6. In a row 12 ft. long, with the plants $1\frac{1}{2}$ ft. apart?

7. In a row 20 ft. long, with the plants $2\frac{1}{2}$ ft. apart?

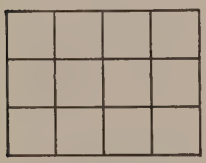
MEASURING RECTANGLES

In a square, all the sides have the same length; in a rectangle, two sides may be longer than the other two.

Every square or rectangle has four square corners, or **right angles,** which look like this: ⌞ ⌝ ⌟

A square foot is a square having each side 1 ft. long. What is a square inch? a square yard? a square mile?

To measure the length of a room, you find how many feet or yards it contains. To measure the area of a rectangle, like a floor, you find how many *square feet* or *square yards* it contains.



This figure represents a rectangle 4 ft. long and 3 ft. wide. Dividing it into small squares of 1 sq. ft. each, you see that it contains (3×4) sq. ft., or 12 sq. ft. Hence its area is 12 sq. ft.

To find the area of a rectangle, multiply its length by its width.

In finding the area of a rectangle, express the length and the width *both* as inches, *both* as feet, or *both* as yards, etc.

Exercises

Find the areas of the following rectangles:

1. 6 ft.×4 ft.
2. 7 yd.×3 yd.
3. 8 ft.×$2\frac{1}{2}$ ft.
4. 12″×5″
5. $9\frac{1}{2}$″×6″
6. $6\frac{1}{2}$″×$6\frac{1}{2}$″
7. $8\frac{1}{2}$ mi.×8 mi.
8. 90 ft.×$40\frac{1}{2}$ ft.
9. 180 yd.×1 yd.

FINDING AREAS IN EVERYDAY LIFE

1. Agnes can knit 1 sq. in. in 5 min. Which will it take her longer to knit, a scarf 44 in. long and 10 in. wide or one 48 in. long and 8 in. wide?

2. Mabel has a piece of gold paper 27 in. long and 6 in. wide. She is making gold stars for a party dress and needs a 3-inch square of paper for each star. How many stars can she make?

3. Cut an old newspaper into squares, each measuring 1 sq. ft. How many of these squares will it take to cover the top of a table 6 ft. by 4 ft.? How could you find the answer without using the paper squares?

4. A hotel is buying some velvet carpet to cover a room 32 yd. long and 28 yd. wide. How much will the carpet cost at $6.25 a square yard?

5. Mr. Mann is varnishing a floor 30 ft. by 25 ft. If 1 gal. of varnish covers 300 sq. ft., how many gallons of varnish does he need?

6. A garage is 9 yd. long and 6 yd. 2 ft. wide. How much will a cement floor for it cost, at $2.40 a square yard?

7. The area of California is 158,297 sq. mi., while the area of Delaware is 2370 sq. mi. California is how many times as large as Delaware? Carry your result to two decimal places.

Find the areas of the following rectangles. Express both dimensions in the same unit before multiplying:

8. 2 ft. $\times$ 6 in.

9. 7 ft. $\times$ 1 yd.

10. $1\frac{1}{3}$ ft. $\times$ 3 in.

11. $\frac{3}{4}$ yd. $\times 1\frac{1}{2}$ ft.

12. $6\frac{1}{2}$ ft. $\times$ 27 in.

13. $4\frac{3}{4}$ ft. $\times$ 30 in.

14. $2'\,4'' \times 6'$

15. $7'\,9'' \times 8'$

16. $2'\,3'' \times 1'\,4''$

TABLE OF SQUARE MEASURE

Review this table of *square measure:*

144 square inches (sq. in.) = 1 square foot (sq. ft.)
9 square feet = 1 square yard (sq. yd.)
$30\frac{1}{4}$ square yards = 1 square rod (sq. rd.)
43,560 sq. ft. or 160 square rods = 1 acre (A.)
640 acres = 1 square mile (sq. mi.)

Exercises

1. How many square feet of concrete are needed for a sidewalk $2\frac{1}{2}$ ft. wide and 30 ft. long? How many square yards are needed? Find the cost at $1.95 a square yard.

2. Some boys are making a baseball diamond 90 ft. square in a field. How many square yards of sod must they remove? If Mr. Jones gives the boys 10¢ a square yard for the sod they remove, how much will they get for it?

3. Frank's mother wishes to put linoleum on her kitchen floor, which is 15 ft. by 12 ft. How much will it cost at $1.85 per square yard?

4. William has a garden 121 ft. long and 45 ft. wide. How much fertilizer should he buy for it if it takes 1000 lb. of this fertilizer per acre?

Tell what numbers should be put in place of the dots:

5. 5 acres = . . sq. rd.
6. 2 sq. rd. = . . sq. yd.
7. 6.5 sq. yd. = . . sq. ft.
8. $1\frac{1}{2}$ sq. ft. = . . sq. in.
9. 0.6 acre = . . sq. ft.
10. 720 sq. rd. = . . A.
11. 2178 sq. ft. = . . A.
12. 80 acres = . . sq. mi.
13. $60\frac{1}{2}$ sq. yd. = . . sq. rd.
14. 360 sq. ft. = . . sq. yd.

IMPROVEMENT TEST No. 21

Test 21 A — Reduction (Time 4 min. after copying)

Change to decimals, correct to the nearest hundredth:

1. $\frac{6}{7}$ 2. $\frac{2}{3}$ 3. $\frac{29}{30}$ 4. $\frac{11}{64}$

5. $\frac{5}{9}$ 6. $\frac{11}{12}$ 7. $\frac{13}{15}$ 8. $\frac{5}{16}$

Test 21 B — Multiplication (Time 4 min. after copying)

1. 809 × .27	2. 3.45 × .57	3. .082 × 8	4. 94.2 × 700
5. 350 × 2.5	6. 4.52 × .09	7. .483 × 1.9	8. 8.5 × 6000
9. 400 × .55	10. .007 × .006	11. .134 × .08	12. .0011 × 900

Test 21 C — Division (Time 4 min. after copying)

Divide, annexing enough zeros to each dividend to make the quotient come out exact:

1. $24\overline{)114}$ 2. $56\overline{)35}$ 3. $450\overline{)769.5}$

Test 21 D — Division (Time 4 min. after copying)

Find each answer correct to the nearest hundredth:

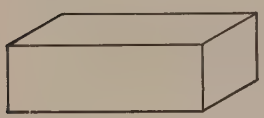
1. $22\overline{)11.9}$ 2. $55\overline{)432}$ 3. $67\overline{)318.9}$

Test 21 E — Division (Time 4 min. after copying)

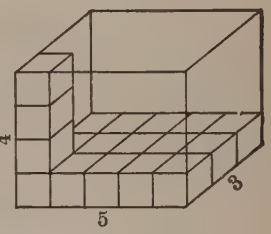
1. $.94\overline{)11.656}$ 2. $.0092\overline{)36.708}$ 3. $7.2\overline{).17352}$

THE VOLUME OF A RECTANGULAR SOLID

A solid shaped like a box is called a **rectangular solid** because its six faces are all rectangles. If its six faces are all squares, it is called **a cube.** A cubic foot is a cube 1 ft. long, 1 ft. wide, and 1 ft. high.



The picture represents a box 5 ft. long, 3 ft. wide, and 4 ft. high. It takes 5×3, or 15, cu. ft., to cover the bottom of the box and 4×15 cu. ft., or 60 cu. ft., to fill the box. Hence its **volume** is (5×3×4) cu. ft., or 60 cu. ft.

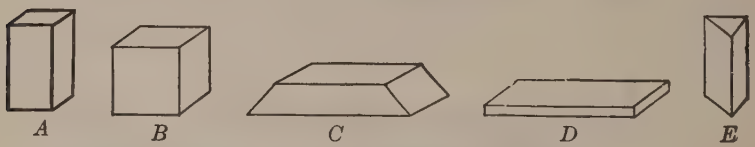


Volume of solid = length × width × height.

Before finding the volume of a solid, express all its dimensions as inches, all as feet, or all as yards, etc.

Exercises

1. *Which of these are rectangular solids or cubes?*



Find the volumes of these rectangular solids:

2. 5 in.×8 in.×8 in.

3. 8 ft.×7 ft.×4 ft.

4. 9 yd.×5 yd.×9 ft.

5. 8 ft.×7 ft.×18 in.

6. $7\frac{1}{2}$ ft.×5 ft.×32 in.

7. $4\frac{2}{3}$ ft.×$11\frac{1}{4}$ ft.×9 ft.

8. $9\frac{1}{3}$ ft.×$5\frac{1}{4}$ ft.×36 in.

9. $10\frac{1}{2}$ ft.×$5\frac{1}{2}$ ft.×4 ft.

FINDING VOLUMES

Review this table of *cubic measure:*

1728 cubic inches (cu. in.) = 1 cubic foot (cu. ft.)
27 cubic feet = 1 cubic yard (cu. yd.)

Problems

1. Our swimming pool is 60 ft. long and 32 ft. wide. When it is filled to a depth of $5\frac{3}{4}$ ft., how many cubic feet of water does it hold?

2. Find the cost of digging a cellar $18' \times 15' \times 7\frac{1}{2}'$ at 65¢ a cubic yard.

3. How many cubic feet of air space has a schoolroom 35 ft. by 30 ft. by 12 ft.? If 200 cu. ft. are needed per pupil, this room is large enough for how many pupils?

4. Last night Jennie dreamed that she had 1,000,000 pieces of chocolate fudge, which filled her room from the floor to the ceiling. If the floor of Jennie's room is 8 ft. 4 in. square, how high would the room have to be to hold exactly 1,000,000 pieces of fudge, each of which is an inch cube?

5. Mabel's room is 10 ft. 5 in. long and 8 ft. 4 in. wide. If she could pile the 1,000,000 pieces of fudge in her room so that they would completely cover the floor, how high would the pile be?

6. Roy said that he would like to pile the 1,000,000 pieces of fudge on a table 8 ft. 4 in. by 6 ft. 8 in. at the School Fair. How high would the pile be?

MEASURING BINS

Memorize these useful facts in *dry measure:*

1 bushel = about 2150 cu. in. or $1\frac{1}{4}$ cu. ft.
1 cubic foot = about .8 bu.
1 ton hard coal = about 35 cu. ft.

A bushel contains exactly 2150.42 cu. in., but in most calculations it would be a waste of time to use this exact value. In practical life, we cannot measure out a bushel of grain so closely as 2150.42 cu. in.

Grain and vegetables are often bought by the weight-bushel instead of by the measured bushel. Thus, a bag of wheat or potatoes is called a bushel if it weighs 60 lb.

Exercises

In ex. 1 *to* 8, *use* 1 *cu. ft.* $= \frac{4}{5}$ *bu. or* 1 *cu. ft.* = .8 *bu.*

1. Mr. Fenton stored his wheat in a bin 10 ft. by 8 ft. by 6 ft. How many bushels did the bin hold?

Find the number of cubic feet and multiply by $\frac{4}{5}$ or by .8.

2. Mr. Nugent builds a bin $6' \times 5' \times 3\frac{1}{2}'$ to hold feed for his horses. How many bushels will it hold?

Tell how many bushels each of these bins will hold:

3. $12' \times 8' \times 5'$ **5.** $9' \times 7' \times 5'$ **7.** $10' \times 8\frac{1}{3}' \times 7\frac{1}{2}'$

4. $8\frac{1}{3}' \times 6' \times 5'$ **6.** $9\frac{2}{3}' \times 6\frac{1}{4}' \times 6'$ **8.** $7\frac{1}{2}' \times 5\frac{1}{4}' \times 2\frac{2}{3}'$

9. A bin 5 ft. wide and 9 ft. long is filled 7 ft. deep with hard coal. How many tons of coal is that?

10. A farmer wishes to make a box that will hold $\frac{1}{2}$ bu. for measuring seed. Tell which of these boxes will most nearly contain $\frac{1}{2}$ bu.:

(*a*) $11'' \times 11'' \times 8\frac{7}{8}''$ (*c*) $11\frac{1}{2}'' \times 11\frac{1}{2}'' \times 8''$

(*b*) $10'' \times 10'' \times 10\frac{3}{4}''$ (*d*) $10\frac{1}{2}'' \times 10\frac{1}{2}'' \times 9\frac{3}{4}''$

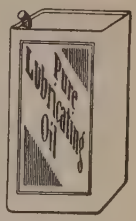
MEASURING WATER AND OTHER LIQUIDS

Learn these useful facts in *liquid measure:*

1 gallon = 231 cu. in.
1 cubic foot = about $7\frac{1}{2}$ gal.

Problems

1. Cora has an aquarium 1 ft. 10 in. long, 14 in. wide, and 16 in. deep. How many gallons of water are needed to fill it $\frac{3}{4}$ full?



2. Andrew bought a can of automobile oil which measured 6 in. by 7 in. by 11 in. How many gallons of oil did it hold?

3. Mary asked the grocer for a pint of olive oil. He gave her a can that measured 5 in. $\times 3\frac{1}{8}$ in. $\times 1\frac{7}{8}$ in. Did this can hold a pint?

4. Using 231 cu. in. = 1 gal., find, to the nearest hundredth of a gallon, how many gallons there are in 1 cu. ft. Is 1 cu. ft. about $7\frac{1}{2}$ gal.?

5. How many gallons of water will fill a swimming pool 40 ft. long and 18 ft. wide to a depth of $5\frac{1}{4}$ ft.?

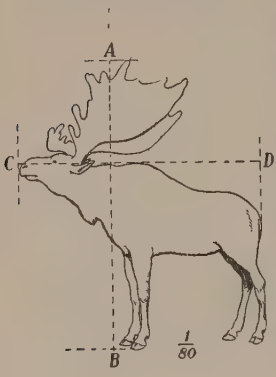
Use 1 cu. ft. = $7\frac{1}{2}$ gal.

6. A broken pipe flooded a cellar to a depth of 5 ft. 3 in. If the cellar is 28 ft. long and 20 ft. wide, how many gallons of water had to be pumped out?

7. During a storm 1 in. of rain fell. How many cubic feet of rain fell on a garden 72 ft. by 40 ft.? How much would it have cost to sprinkle the same amount of water on the garden at 28¢ per 100 cu. ft.?

HOW TALL IS THE MOOSE?

Under the picture of a moose in the dictionary, Agnes finds the fraction $\frac{1}{80}$. This tells the scale to which the picture is drawn, and means that each measurement in the picture is $\frac{1}{80}$ as great as the same measurement in a real moose. Agnes measures the line AB and finds it to be $1\frac{1}{2}$ in. long. Hence the real height of the moose is $80 \times 1\frac{1}{2}$ in., which equals 120 in., or 10 ft. Measure the line CD and find the real length of the moose.



Exercises

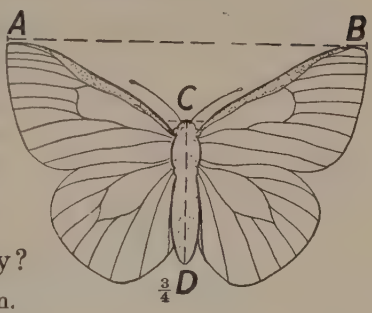
1. In a large dictionary see whether there are pictures with the words *ostrich*, *zebra*, *lion*, and *tiger*. If there are, find the scale of each picture. On the picture measure, to the nearest $\frac{1}{16}$ in., the length and the height of each animal; then find its real length and height.

Agnes made these measurements on some pictures of animals. Find the real height and length of each:

	NAME	SCALE	HEIGHT	LENGTH
2.	Giraffe	$\frac{1}{100}$	$1\frac{3}{4}$ in.	1 in.
3.	Buffalo	$\frac{1}{60}$	$1\frac{3}{8}$ in.	$1\frac{7}{8}$ in.
4.	Kangaroo	$\frac{1}{48}$	$\frac{7}{8}$ in.	$2\frac{3}{8}$ in.
5.	Squirrel	$\frac{1}{7}$	$\frac{3}{4}$ in.	$1\frac{1}{4}$ in.
6.	Large bear	$\frac{1}{48}$	1 in.	$1\frac{1}{2}$ in.
7.	Elephant	$\frac{1}{108}$	$1\frac{1}{16}$ in.	$1\frac{3}{8}$ in.
8.	Catbird	$\frac{1}{8}$	$\frac{5}{8}$ in.	$1\frac{1}{2}$ in.

MEASURING A BUTTERFLY

Under the picture of a butterfly, Agnes finds the fraction $\frac{3}{4}$. This means that each measurement in the picture is $\frac{3}{4}$ of the same measurement in a real butterfly. If $AB = 1\frac{7}{8}$ in., how wide is the real butterfly?



$\frac{3}{4}$ of the width $= 1\frac{7}{8}$ in., or $\frac{15}{8}$ in.
$\frac{1}{4}$ of the width $= \frac{15}{8}$ in. $\div$ 3, or $\frac{5}{8}$ in.
$\frac{4}{4}$ of the width $= 4 \times \frac{5}{8}$ in., or $2\frac{1}{2}$ in.
Hence the real butterfly is $2\frac{1}{2}$ in. wide.

Measure CD and find the real length of the butterfly.

Exercises

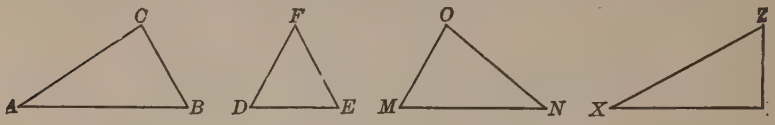
Agnes measured pictures of these insects. Find the real width and length of each insect:

NAME	SCALE	WIDTH, WING TIP TO WING TIP	LENGTH, FROM HEAD TO TAIL
1. Moth . . .	$\frac{2}{3}$	2 in.	$\frac{2}{3}$ in.
2. Bee (Queen)	$\frac{3}{4}$	$\frac{15}{16}$ in.	$\frac{3}{4}$ in.
3. Bee (Worker)	$\frac{3}{4}$	$\frac{15}{16}$ in.	$\frac{15}{32}$ in.
4. Butterfly .	$\frac{5}{8}$	$1\frac{9}{16}$ in.	$\frac{5}{16}$ in.
5. Butterfly .	$\frac{3}{4}$	$2\frac{7}{16}$ in.	$\frac{3}{4}$ in.
6. Dragon fly .	$\frac{1}{3}$	$1\frac{1}{16}$ in.	$\frac{3}{4}$ in.
7. Hornet . .	$\frac{5}{6}$	$1\frac{1}{4}$ in.	$\frac{5}{8}$ in.
8. Horsefly . .	$\frac{7}{10}$	$1\frac{5}{16}$ in.	$\frac{21}{32}$ in.

9. Under the picture of a fly, Robert finds $\frac{1}{1}$ as the scale. What do you think this means?

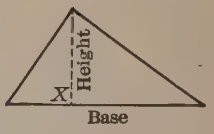
LEARNING SOME NEW THINGS ABOUT TRIANGLES

Triangles are figures having three sides, like these:

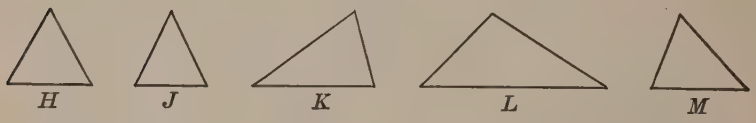


The side on which a triangle stands is its **base.** In the triangle ABC above, side AB is the **base.** What is the base of each of the other triangles?

The **height** of a triangle is the distance from its *highest point to its base.* In the triangle at the right the dotted line, which makes a right angle with the base at X, shows the height. Hence the height of a triangle is **perpendicular** to its base.



Exercises



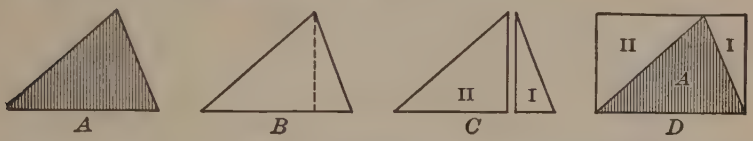
1. Copy the above triangles and show the height of each with a dotted line.

2. Copy the triangles at the top of this page and draw the height of each.

3. These boys are trying to measure the *height* of the front of the tent. Are they holding the string correctly?

HOW TO FIND THE AREA OF A TRIANGLE

From a piece of cardboard cut two triangles like *A*, each having a base of 4 in. and a height of $2\frac{1}{2}$ in. Shade one of these triangles, as shown in *A*.



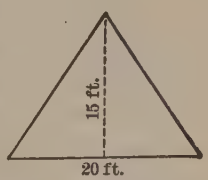
On the unshaded triangle draw a dotted line showing the height, as in *B*. Cut along this dotted line, dividing *B* into parts I and II, as in *C*. Place I and II around the shaded triangle to form a rectangle, as in *D*.

You have made a rectangle from the two equal triangles with which you started. Hence each triangle is half of the rectangle. The area of the rectangle equals its base times its height. As the triangle is just half as large as the rectangle, you have this rule:

Area of triangle $= \frac{1}{2} \times$ *base* $\times$ *height.*

Exercises

1. Ella's garden has the shape of a triangle with a base of 20 ft. and a height of 15 ft. Find its area.



Multiplying the base by the height, you get 20×15, or 300. Taking $\frac{1}{2}$ of 300, you have 150. Hence the area of Ella's garden is 150 sq. ft.

Find the areas of these triangular gardens. The first number shows the base and the second, the height:

2. 30 ft., 16 ft. **4.** 7 yd., 5 yd. **6.** 9 rd., 7 rd.

3. 24 ft., 15 ft. **5.** 6 ft., $4\frac{1}{2}$ ft. **7.** 15 yd., 10 yd.

SAIL BOAT PROBLEMS

1. This picture shows Dan's canoe. Its triangular sail has a base of 9 ft. and a height of 7 ft. How many square feet of sail area has it?

2. Uncle Silas tells Dan that a brisk wind pushes against the sail with a force of 2.5 lb. per square foot, while in a high wind the pressure is 5 lb. per square foot. How many pounds' pressure does a brisk wind make on Dan's sail (ex. 1)? What pressure does a high wind make on it?

3. Uncle Silas says that it is not safe on an open canoe to use a larger sail than Dan's (see ex. 1). Find the areas of sails with the following bases and heights and tell which would be safe for Dan to use:

(*a*) $7\frac{1}{2}$ ft., 8 ft. (*c*) 10 ft., $6\frac{1}{4}$ ft. (*e*) $9\frac{1}{2}$ ft., $8\frac{1}{2}$ ft.
(*b*) $8\frac{1}{2}$ ft., 8 ft. (*d*) 9 ft., $7\frac{1}{2}$ ft. (*f*) 10 ft., $8\frac{1}{2}$ ft.

4. Richard has a regular sailing canoe whose triangular sail has a base of $13\frac{1}{2}$ ft. and a height of $11\frac{3}{4}$ ft. How many square feet are there in this sail? How many pounds of pressure are there on this sail in a brisk wind? in a high wind? (Use data in ex. 2.)

5. Fred found that the area of the sail on his boat could not with safety be more than 50 sq. ft. Try to find the base and the height for three different triangular sails each having an area of 50 sq. ft. or less.

IMPROVEMENT TEST No. 22

Test 22 A — Finding Per Cents (Time 4 min. after copying)

1. 5% of 360	**2.** 75% of 264	**3.** $66\frac{2}{3}$% of 621
4. 38% of 150	**5.** 82% of 750	**6.** 200% of 714
7. 85% of 320	**8.** 50% of 820	**9.** 350% of 760

Test 22 B — Finding Per Cents (Time 4 min. after copying)

Find results correct to the nearest cent:

1. $16\frac{2}{3}$% of \$28	**2.** 29% of \$320.08
3. 2% of \$83.77	**4.** $12\frac{1}{2}$% of \$455.50
5. 11% of \$50.75	**6.** 105% of \$640.80

Test 22 C — Comparing Numbers (Time 4 min. after copying)

Tell what numbers should be put in place of the dots:

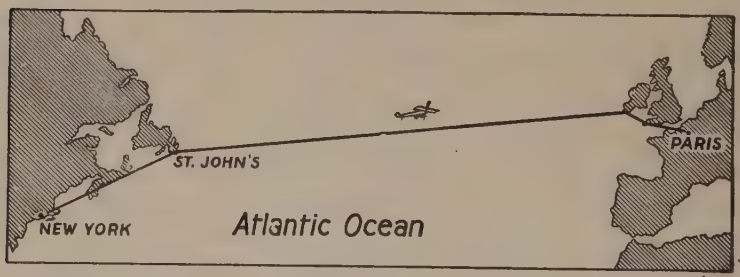
1. 24 is . . % of 96	**2.** 120 is . . % of 125
3. 39 is . . % of 300	**4.** 180 is . . % of 450
5. 62 is . . % of 496	**6.** 207 is . . % of 300

Test 22 D — Comparing Numbers (Time 4 min. after copying)

Tell what numbers should be put in place of the dots:

1. 42 is . . % of 70	**2.** 12 is . . % of 150
3. 51 is . . % of 68	**4.** 92 is . . % of 400
5. 5 is . . % of 500	**6.** 110 is . . % of 125

LINDBERGH FLIES ACROSS THE ATLANTIC



Find all answers to the nearest tenth of a unit.

1. Clyde read that Lindbergh, on his non-stop flight across the Atlantic Ocean from New York to Paris, flew 3647 mi. in 33.5 hr. He flew at an average speed of how many miles an hour?

2. Lindbergh had 450 gal. of gasoline at the beginning of the flight. He used 432 gal. in traveling the 3647 mi. How many miles did he fly, on an average, on 1 gal. of gasoline?

3. Clyde read that Lindbergh traveled alone. He asked his father why Lindbergh did not take a man along to help him. His father said, "A gallon of gasoline weighs 6.12 lb. Hence for every 6.12 lb. of the weight of a companion, a gallon of gasoline would have to be sacrificed." How many gallons of gasoline would Lindbergh have had to sacrifice to make up for the weight of a 160-pound man?

4. Lindbergh had 18 gal. of gasoline left when he reached Paris. Could he have reached Paris if he had taken the man instead of the extra gasoline?

Use the answer in ex. 3 in working this problem.

5. How many miles farther than Paris would the 18 gal. of gasoline he had left have taken Lindbergh if each gallon had carried him the same number of miles that he averaged during the trip?

Use the number of miles per gallon found in ex. 2.

6. When Lindbergh left New York, his empty plane with its instruments weighed 2150 lb. It carried as its load 450 gal. of gasoline weighing 6.12 lb. a gallon, 25 gal. of oil weighing 7 lb. per gallon, 45 lb. of miscellaneous load, and Lindbergh, who weighed 170 lb. How much did the plane with its entire load weigh?

7. How many gallons of gasoline per hour, on an average, did Lindbergh's plane consume if it used 432 gal. in 33.5 hr.?

8. Lindbergh left New York at 7.52 A.M. and passed over St. John's, Newfoundland, at 7.15 P.M. Show that this part of the trip took about 11.4 hr.

9. If he used 12.9 gal. of gasoline per hour, how much lighter was his plane when he passed over St. John's than when he left New York? (Use facts in ex. 6 and 8.)

10. How many passengers averaging 150 lb. each could Lindbergh have carried from St. John's to Paris to make up for the loss in weight of gasoline between New York and St. John's? (Use the answer to ex. 9.)

11. Ex. 6 tells how much the loaded plane weighed when Lindbergh left New York. If on the entire trip he used 432 gal. of gasoline and 11.8 gal. of oil, how much lighter was his plane when he landed at Paris than it was when he started?

FRACTIONS AND MEASURES

Tell what numbers should be put in place of the dots:

1. $2\frac{1}{2}$ yd. = . . . in.
2. $2\frac{3}{4}$ mi. = . . . ft.
3. 64 rd. = . . . mi.
4. 72 oz. = . . . lb.
5. 5 min. = . . . hr.
6. $3\frac{1}{2}$ yr. = . . . mo.
7. 96 pt. = . . . bu.
8. $5\frac{1}{4}$ gal. = . . . pt.
9. 9 ft. 3 in. = . . . ft.
10. 2 lb. 7 oz. = . . . oz.
11. 2 ft. 3 in. = . . . yd.
12. $2\frac{1}{2}$ sq. mi. = . . . A.
13. 486 sq. ft. = . . . sq. yd.
14. $18\frac{3}{4}$ cu. yd. = . . . cu. ft.
15. 108 sq. in. = . . . sq. ft.
16. 450 cu. ft. = . . . cu. yd.

Add the following and check the work:

17. $4\frac{5}{8}$ lb. + $2\frac{3}{4}$ lb. + $7\frac{1}{2}$ lb. + $6\frac{5}{16}$ lb.
18. $1\frac{1}{3}$ hr. + $5\frac{3}{4}$ hr. + $6\frac{1}{2}$ hr. + $\frac{5}{6}$ hr.
19. $7\frac{1}{2}$ yd. + $2\frac{1}{4}$ yd. + $6\frac{5}{8}$ yd. + $3\frac{7}{8}$ yd.
20. $6\frac{1}{5}$ sec. + $8\frac{1}{2}$ sec. + $7\frac{7}{10}$ sec. + $6\frac{9}{10}$ sec.

Subtract the following and check the work:

21. $8\frac{3}{4}$ yd. − $2\frac{7}{8}$ yd.
22. 6 lb. − $3\frac{5}{16}$ lb.
23. $19\frac{7}{10}$ mi. − $18\frac{1}{2}$ mi.
24. $5\frac{1}{12}$ ft. − $2\frac{7}{12}$ ft.

Multiply or divide, as the problem indicates:

25. $6\times\frac{7}{8}$
26. $\frac{2}{3}\times\frac{9}{10}$
27. $\frac{3}{4}\times64$
28. $\frac{7}{8}\times50$
29. $11\times\frac{3}{4}$
30. $5\times18\frac{1}{4}$
31. $18\times\frac{1}{16}$
32. $14\times5\frac{1}{2}$
33. $12\times1\frac{1}{8}$
34. $2\frac{2}{3}\times10$
35. $5\frac{1}{3}\times4\frac{1}{8}$
36. $3\frac{5}{8}\times240$
37. $16\div3\frac{1}{2}$
38. $1\frac{1}{2}\div4\frac{1}{2}$
39. $3\frac{3}{8}\div\frac{3}{4}$
40. $21\frac{1}{4}\div2\frac{1}{2}$
41. $5\div\frac{1}{8}$
42. $\frac{3}{4}\div\frac{7}{8}$
43. $\frac{3}{4}\div\frac{3}{4}$
44. $\frac{3}{16}\div\frac{1}{4}$
45. $2\frac{1}{2}\div5$
46. $3\frac{1}{8}\div5$
47. $11\div3\frac{1}{7}$
48. $10\div2\frac{1}{2}$

CAN YOU SOLVE ALL THESE PROBLEMS?

1. A store advertises hats "at $33\frac{1}{3}\%$ off." How much does Ruth pay for a hat originally marked \$7.50?

2. In a test of 50 words Edwin's mark was 70%. How many words had he right? How many had he wrong?

3. In a test of 75 words Louise got 72 words right. What per cent should her paper be marked?

4. In May, Dan spent 68% of his wages and saved the rest. What per cent of his wages did he save?

5. Ann has \$150 in a bank which pays 4% interest. How much interest does Ann get each half year?

6. An agent sold Mr. Day's car for \$600, charging 6% commission. How much of the \$600 did Mr. Day receive?

7. Last summer Harry sold candy costing \$20 for \$36. He gave Bob \$4 for helping him. What was Harry's per cent of profit on the cost? on the selling price?

8. The men in a shoe factory had their wages increased 5%. If Ada's father used to earn \$6 a day, how much did he earn after the increase?

9. Last year the population of our city was 12,600. Now it is 40% greater. What is the population now?

Say these in percentage language:

10. Only $\frac{3}{4}$ of the Lake City pupils took part in the Field Day exercises.

11. Ella's dress is guaranteed to be all wool.

12. Mr. Young sold his house on Wasnington Street for twice as much as he paid for it.

13. Mr Thomas spends $\frac{9}{50}$ of his salary for rent.

PROBLEMS FOR A GOOD THINKER

1. If Bernard knows how many feet high Victory Hill is, how can he find, to the nearest hundredth of a mile, what decimal part of a mile its height is?

2. Claudia Mitchell is selling soap this summer at 35% commission. If she has a record of each day's sales for a week, how can she find what her commission for that week should be?

In ex. 3, 4, *and* 5, *a necessary fact has been left out. Supply the fact and work the problem:*

3. Margery had 45 words on a spelling test right. What per cent should she be marked?

4. On a trip to Florida and back, Mr. Allen drove his car a total of 4356 mi. How many miles a day did he average?

5. If Mr. Tripp averages 106.3 mi. an hour in his airplane, how long will it take him to reach Spokane, Wash., from his home?

In ex. 6, 7, *and* 8, *make up a question that uses all the given facts, and answer it:*

6. In making some bookshelves, Charles cut a board into 4 pieces, each piece being 3 ft. 5 in. long.

7. Our class bought \$18 worth of ice cream to sell at the fair. We paid \$3.50 to rent dishes and made a profit of 15% on the cost.

8. Ruth Waterman has \$450 in a savings bank that pays 4% interest. If she had lent the money to Mr. Eldridge instead of putting it in the bank, he would have paid her 6% interest.

TABLES FOR REFERENCE

Linear Measure

12 inches (in.) = 1 foot (ft.)
3 feet = 1 yard (yd.)
$16\frac{1}{2}$ feet or $5\frac{1}{2}$ yards = 1 rod (rd.)
5280 feet or 320 rods = 1 mile (mi.)

Liquid Measure

2 pints (pt.) = 1 quart (qt.)
4 quarts = 1 gallon (gal.)

Dry Measure

2 pints (pt.) = 1 quart (qt.)
8 quarts = 1 peck (pk.)
4 pecks = 1 bushel (bu.)

Weight

16 ounces (oz.) = 1 pound (lb.)
100 pounds = 1 hundredweight (cwt.)
2000 pounds = 1 ton (T.)

Time

60 seconds (sec.) = 1 minute (min.)
60 minutes = 1 hour (hr.)
24 hours = 1 day (da.)
7 days = 1 week (wk.)
365 da. or 12 months (mo.) = 1 year (yr.)
366 days = 1 leap year
100 years = 1 century

Counting Articles

12 units = 1 dozen (doz.)
12 dozen or 144 units = 1 gross
20 units = 1 score

Counting Paper

24 folded sheets or 25 unfolded sheets = 1 quire
20 quires = 1 ream

Square Measure

144 square inches (sq. in.) = 1 square foot (sq. ft.)
9 square feet = 1 square yard (sq. yd.)
30¼ square yards = 1 square rod (sq. rd.)
43,560 sq. ft. or 160 sq. rd. = 1 acre (A.)
640 acres = 1 square mile (sq. mi.)

Cubic Measure

1728 cubic inches (cu. in.) = 1 cubic foot (cu. ft.)
27 cubic feet = 1 cubic yard (cu. yd.)

Useful Equivalents

1 bushel = about 2150 cu. in. or 1¼ cu. ft.
1 cubic foot = about .8 bu.
1 gallon = 231 cu. in.
1 cubic foot = about 7½ gal.
1 barrel = 31½ gal.
1 ton hard coal = about 35 cu. ft.
1 ton soft coal = about 42 cu. ft.
1 cord of wood = 128 cu. ft.

INDEX

Account, cash 1, 2, 4
charge 263, 265
Addition
checking 3
improvement tests in 11, 21, 55, 73, 119, 141, 185, 205, 237
of compound numbers . . 313
of decimals 156, 221
of dollars and cents 1, 6, 15, 187
of fractions . . 45, 50, 53, 59, 63, 66, 68, 201
of whole numbers . . . 5, 86
Aliquot parts 127
Area, of a rectangle . . 142, 322
of a triangle 333
Averages 113

Balance 2, 268
Bank accounts 268
Billions 186
Bills 263, 265

Cancellation 79, 94, 96
Cash account 1, 2, 4
Change, making 9
Check, indorsing a 267
Checking computations
with decimals . . 157, 159, 164, 171, 174, 225, 246
with fractions . . 47, 57, 64, 67, 68, 83, 87, 112, 212
with whole numbers . . 3, 7, 15, 17, 22, 24, 171
Circumference 232
Commission 293, 294
Common denominator . 68, 70. 71
Comparing numbers
by division 121
by fractions 123, 289
by per cents 291
Compound numbers, addition of 313
division of 319
multiplication of 318
reduction of 312
subtraction of 315
Cube 148, 326
Cubic measure . . 150, 327, 328, 329, 342

Decimal point, practice in placing . . . 170, 218, 233, 253
use of 152
Decimals, addition of . . 156, 221
comparing 220
division of . 171, 238, 245, 251
ending in fractions 244
fractions equivalent to . 153, 162, 174, 224, 241, 244, 256, 290
improvement tests in 269, 325
in percentage 272, 273
incomplete 175, 242
mixed 154, 214
multiplication of . 163, 166, 228
reading and writing . 152–154, 214, 215
reduction of . . . 162, 219, 224
reduction to . . 174, 175, 241, 242, 244, 256, 290
subtraction of 158, 225
uses of . . 155, 160, 161, 172, 216, 221, 223, 225, 229, 243, 258
Degree of accuracy
of measurement . . 216, 217, 221
of results . 85, 87, 207, 228, 238, 242, 306, 328
Denominate numbers 309, 341, 342
(*See also* Compound numbers)
Denominator 38
common 68
least common 70, 71

Difference 7
Discount 40, 298–301
Dividend 22
Divisibility, tests of . . . 77, 78
Division, by 10 and 100 . 235, 236
checking 22, 24, 171
comparing numbers by . . 121
improvement tests in . . 31, 55, 73, 119, 141, 185, 205
long 24, 26, 30, 173
of compound numbers . . 319
of decimals . 171, 238, 245, 251
of dollars and cents . 22, 29, 190
of fractions . 109, 114, 115, 212
of whole numbers 22, 24, 30, 190
remainders in . . 22, 24, 26, 42, 80, 174
short 22
ways of expressing 42
zeros in 28, 235
Divisor 22
Dollar, parts of a 127
Dollars and cents
addition of . . . 1, 6, 15, 187
division of . . . 22, 29, 190
multiplication of . . . 15, 189
subtraction of 7, 188
Dozen 140, 342
Drawing to scale 146, 330
Drills (*see* Graded Exercises)
Dry measure . 135, 310, 328, 341

Estimating answers . . 33, 34, 282

Factor 15, 79
Fractional parts . . 39, 123, 126, 207, 289
Fractions
addition of . . 45, 50, 53, 59, 63, 66, 68, 201
common 38, 152
comparing . . . 47, 48, 62, 65
comparing numbers by . 123, 289
decimal 152
decimals equivalent to 153, 162, 174, 175, 224, 241, 244, 256, 290
Fractions
division of . 109, 114, 115, 212
improper . 43, 44, 98, 201, 203
improvement tests in . . 91, 101, 129, 151, 169, 227, 255, 285
in percentage 277, 279, 280, 290
in the quotient . . 42, 80, 174
multiplication of . . 82, 87, 92, 99, 105, 207, 209, 210
proper 43, 200
reduction of . . 44, 49, 52, 58, 59, 62, 65, 79, 80, 198
showing division by . . . 41
subtraction of 56, 60, 64, 67, 204
terms of 38

Games, with fractions . 59, 74, 75, 76, 105, 106
with whole numbers . . . 8
Graded exercises
on decimals . . 157, 159, 164, 167, 173, 176, 222, 226, 230, 233, 239, 245, 246, 247, 252, 253
on fractions . . 46, 47, 50, 51, 54, 57, 60, 61, 63, 64, 66, 67, 68, 71, 72, 82, 83, 84, 85, 86, 87, 93, 95, 97, 100, 111, 112, 116, 118, 211, 213
on percentage . . 276, 279, 281, 283, 286, 287, 288, 302, 303, 304, 306
on whole numbers . . 16, 18, 23, 25, 27, 28, 30
Graphs 14, 184

Hundredths . . 153, 214, 216, 272

Improper fraction . . . 43, 44, 98, 201, 203
Improvement tests
in addition . . 11, 21, 55, 73, 119, 141, 185, 205, 237
in decimals 269, 325
in division . . 31, 55, 73, 119, 141, 185, 205

Improvement tests
in fractions . . . 91, 101, 129, 151, 169, 227, 255, 285
in multiplication . . 21, 31, 55, 73, 119, 141, 185, 205
in percentage 307, 335
in subtraction . . 11, 21, 55, 73, 119, 185, 205, 237
keeping records in . . . 14, 184
scoring 13
taking 10, 12, 90, 183
Indorsing a check 267
Interest 302–306

Least common denominator 70, 71
Length, comparing 132
measures of . . . 131, 309, 341
Liquid measure 134, 311, 329, 341
List price 300
Long division . . 24, 26, 30, 173
Lowest terms 49

Magic squares 74, 76
Making change 9
Measurement, accuracy of . 216, 217, 221
Measures (*see* Tables)
Millions 36, 186
Millionths 214
Minuend 7
Mixed numbers . 44, 98, 200, 203
Multiplicand 15
Multiplication, by 10 and 100 234
checking 15, 17
improvement tests in . 21, 31, 55, 73, 119, 141, 185, 205
of compound numbers . . 318
of decimals . . . 163, 166, 228
of dollars and cents . . 15, 189
of fractions . . 82, 87, 92, 99, 105, 207, 209, 210
of whole numbers . . . 16, 189
saving time in 19
zeros in 18, 234
Multiplier 15

Net price 300
Net proceeds 293
Numerator 38

Overhead expenses 295

Parcel post 270
Parts of a dollar 127
Per cents, finding 272, 276
fractions equivalent to . . 277–280, 290
large 283, 286, 288
Percentage, applications of 293–307
comparing numbers in . . 291
estimating answers in . . . 282
improvement tests in . . 307, 335
language of . . . 274, 283–287
meaning of 272
short cuts in . . . 277, 279, 280
using decimals in . . . 272, 273
Perimeter 320
Perpendicular 332
Principal 302
Problems
for completion . . 194, 195, 340
solving . . 35, 187–197, 262, 339
with unnecessary facts . . 196
without numbers 193
Problems about
Airplanes 251, 336
Animals 330
Arithmetical recreations . 74–76, 105–106, 256
Automobile trips . 155, 158, 258
Bicycles 232
Cost of running a car . . . 308
Electricity 102, 103
Farms 36, 145, 250
Gardens 145, 321
Geography 172, 281
Home-made alarm clock . . 120
Insects 331
Keeping chickens 179
Living 1000 years 197
Magic squares 74–76
Mail orders 51, 270

Problems about
Making a flag . . . 248, 249
Making candy 104
Making rafts 231
Maple sugar 178
Rainfall 160, 161, 172
Sailboats 334
Scale drawing 146, 147, 330, 331
School papers 86
Shopping . . 20, 40, 50, 88, 128, 202, 208, 298, 299
Sports 64, 66, 107, 204, 316–317
Thrift 40, 250, 257, 297, 299, 305
Tractors 250
Proceeds, net 293
Product 15
Profit and loss . . . 295–297, 305
Projects (*see* Problems about)
Proper fraction 43, 200

Quotient 22

Reading large numbers . . 36, 186
Receipts 263, 266
Rectangle 142, 322
Rectangular solid 326
Reduction, of decimals 162, 219, 224
of denominate numbers . . 312
of fractions . . 44, 49, 52, 58, 59, 62, 65, 79, 80, 198
of mixed numbers . . . 98, 203
Remainders, in division . . 22, 24, 26, 42, 80, 174
in subtraction 7
Reviews 107, 178–182, 257–262, 336–340
Right angle 142, 322
Roman numerals 37

Sales slip 207
Scale drawing 146, 330
Scoring, table for 13
Short division 22
Solid, rectangular 326
Solving problems . . 35, 187–197, 262, 339
Square 142, 322
Square measure . . 144, 324, 342
Subtraction
checking 7
improvement tests in . . 11, 21, 55, 73, 119, 185, 205, 237
of compound numbers . . 315
of decimals 158, 225
of dollars and cents . . 7, 188
of fractions . 56, 60, 64, 67, 204
of whole numbers . . . 8, 188
Subtrahend 7

Tables, for counting articles 140, 342
for counting paper . . . 140, 342
of cubic measure . 150, 327, 342
of dry measure . 135, 310, 341
of length 131, 309, 341
of liquid measure . 134, 311, 341
of square measure . 144, 324, 342
of time 138, 311, 341
of useful equivalents . . . 342
of weight 136, 310, 341
Tenths 153, 214, 216
Terms of a fraction 38
Tests (*see* Improvement tests)
Tests of divisibility . . . 77, 78
Thousands 36, 186
Thousandths 153, 214
Time, measures of . 138, 311, 341
Trade discount 300
Triangle 332, 333

Unit of measure 130
Units 36, 43, 140, 186

Volumes, finding 148, 326

Weight, measures of . 136, 310, 341
Whole number 44

Zeros, in division 28, 235
in multiplication . . . 18, 234

LIST OF IMPROVEMENT TESTS

Number of Test	Subject	Page
1	Whole numbers	11
2	Whole numbers	21
3	Whole numbers	31
4	Whole numbers	55
5	Whole numbers	73
6	Fractions	91
7	Fractions	101
8	Whole numbers	119
9	Fractions	129
10	Whole numbers	141
11	Fractions	151
12	Fractions	169
13	Whole numbers	185
14	Whole numbers	205
15	Fractions	227
16	Whole numbers	237
17	Fractions	255
18	Decimals	269
19	Fractions	285
20	Percentage	307
21	Decimals	325
22	Percentage	335

SCORING TABLE FOR IMPROVEMENT TESTS

NUMBER OF EXAMPLES IN TEST ↓	NUMBER OF EXAMPLES RIGHT																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
3	0	3	7	10													
4	0	3	5	8	10												
5	0	2	4	6	8	10											
6	0	2	3	5	7	8	10										
8	0	1	3	4	5	6	8	9	10								
9	0	1	2	3	4	6	7	8	9	10							
10	0	1	2	3	4	5	6	7	8	9	10						
12	0	1	2	3	3	4	5	6	7	8	8	9	10				
15	0	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	
16	0	1	1	2	3	3	4	4	5	6	6	7	8	8	9	9	10

For directions for using this table, see page 13.

S. U. AR. — M. G. (2)

AB
C